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The New Systematics, the New Anatomy, and the New Natural History[1]

By Karl P. Schmidt

WHEN our valued secretary called my attention to the fact that I must now take my place among the elder statesmen of the Society, and that as your retiring president a few remarks from me would be appropriate, I could not deny my age, for I have grown appreciably older even in this office. Perhaps, by looking back over my own time and forward to what I regard as yours, I may aid the younger generation among you in taking stock of the past and in striking out into the new roads of the future. Indeed, many of the new roads now being laid out are so new that I shall not travel them myself. I may take as a text, as appropriate to all of us who turn the corner of old age, that profoundly poetic passage in Deuteronomy in which the older leader is vouchsafed a distant view of a Promised Land:

> And I besought Jehovah saying, Oh Lord Jehovah, Let me go over, I pray thee, and see the good land that is beyond the Jordan, that goodly mountain, and Lebanon. But Jehovah said unto me, Let it suffice thee; get thee up unto the top of Pisgah, and lift up thine eyes westward, and northward, and southward, and eastward, and behold with thine eyes; for thou shalt not go over this Jordan.[2]

I ask the indulgence of my older colleagues in this audience, who will understand that I am well aware that one may not instruct one's grandmother about the facts of life. Indeed, I hesitate to address you at all, for many things that are still new to me are already commonplace to many of my younger colleagues.

The New Systematics

Most of us here are interested in the *species* of amphibians, reptiles, and fishes; we have lived through an era in which this interest, and indeed the interest in classification as a whole, was regarded by many of our biological colleagues as of a low order. Our researches in classification, and in comparative anatomy, were no longer admitted to be worthy of the degree of Doctor of Philosophy at most universities. The few vertebrate systematists, preserved as relict populations in the protected environment of the larger museums, and in the vanishingly small number of universities that have museum interests, have managed to keep some continuity of systematic research, aided by the still strongly systematic fields of entomology and paleontology. I regard the job of systematic zoology and botany as a noble one. It is the preparation of a description of the life of the world, and the system of classification makes possible the compression of this description in a way essentially no different from the shorthand description of nature in the scientific generalizations of the physical sciences.

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1 Address of the retiring president at the Annual Banquet of the American Society of Ichthyologists and Herpetologists. April 17, 1946.

2 Abbreviated from Deuteronomy 3:23–29.

Perhaps I may be allowed to comment on the attitude of our university colleagues that I find most inexcusable. A glance at the lists of Ph.D. theses of the major universities will disclose any number whose permanent contribution to science is obviously less than is that of almost any systematic revision of a genus of snakes or lizards or frogs. What some university men seem to do is to hasten into the field that at the moment is popular, without taking stock to see if the older fields, whether descriptive or experimental, need further work, and with no provision for the continuance of work in them. They wish to skim the cream and throw away the skimmed milk. It is to this attitude on the part of biologists that we owe the disgraceful fact that there is no "Fauna of North America" remotely comparable to the whole shelf of uniform volumes of the Fauna of British India. Systematic zoology and botany lie at the foundations of biology, and it is elementary for a sound structure to look to the foundations. I once attended a distinguished round table on the education of biologists. There was no mention of the vast variety of possible biological interests or of the need for any further descriptive zoology and botany, or of descriptive and comparative anatomy. The tenor of the discussion at this gathering, which was to the effect that all students of the future must prepare to study mathematical biophysics and biochemistry, at last moved me to protest. My remark, to which I still hold, was that a year's work on a farm was more essential as preparation for a career in biology than a knowledge of the calculus.

Some ten or fifteen years ago a remarkable change of heart took place among some of the leaders of university biology, and specifically of genetics, from which field had come the classic remark that museum zoologists were in the postage stamp stage. The unthinkable took place, and on the hills of California geneticists were to be seen pursuing their prey, bug net in hand, in nature. There is now a considerable crop of books expressing the trend to restore systematic studies to respectability. I will remind you only of Huxley's "The New Systematics," Dobzhansky's "Genetics and the Origin of Species," George Gaylord Simpson's "Tempo and Mode in Evolution," and Mayr's "Systematics and the Origin of Species."

What of the old systematics? Was there indeed reason for a "New Systematics"? Let us search some of our own shortcomings.

My own career spans the entire history of the International Code of Zoological Nomenclature, and I must confess that I now agree with some of my non-taxonomist colleagues that the activity of name-changing and of argument over names was a barren one. The framers of the code, in restrospect, were disingenuous men, lawyers rather than zoologists, and engaged in making scholarship esoteric rather than functional. The code itself is so unclear that Leonhard Stejneger, one of its own framers, has argued in the case of the name *Crocodylus* for interpretation according to the spirit, and in another, *Trionyx,* for interpretation according to the strictest letter of the law. Nomenclature, instead of being the handmaiden of systematics, became an end in itself, and it became fashionable to change names, and to be up to date on the latest changes, however transient. I was myself drawn into nomenclatural research, but I now renounce the error of my ways and denounce the search for priority as a dubious service even to the stability of nomenclature. When the common names of birds became more stable than the scientific, the whole

matter of nomenclatural "research" was reduced to absurdity. I heartily concur with the author [3] of a thoughtful recent work on the species problem that much name-changing could be prevented if there were a few simple exceptions to the rules of priority, if, for example, no name in general use for thirty years or more could be replaced by an older name (a *nomen oblitum*) or that no name generally applied to one group for ten or more years could be transferred to another. In fact, the only rule in the International Code to which I now heartily subscribe is the final one enabling the suspension of the rules in cases in which confusion rather than stabilization would be introduced by their strict application. There are so many first rate zoological problems that require attention that the waste of time and paper on nomenclature is nothing short of calamitous. It must be understood, of course, that I regard the combinations and permutations of synonymy as zoology, not nomenclature, and that it is the changing of names for the sake of nomenclatural rules that I here denounce. I may suggest a simple rule that would contribute more to the stability of nomenclature than the entire code: let every perpetrator of the change of a name on purely nomenclatural grounds pay $100 to validate the proposed change, payable to the appropriate society treasury, the funds to be applied to the promotion of zoological research. We have erred in making the changing of names fashionable. I wish it to become unfashionable and indeed opprobrious.

As for our descriptions of species and our contributions to the classification of the animal kingdom, it is evident that a major change has come over systematic research. We now realize what was sometimes forgotten by the older generation of systematists, that museum specimens are mere counters, that species are composed of intrinsically variable populations in nature, that collecting is a method of sampling, and that the range of variation may itself be a species character. There has fortunately been little history in America of the "closet naturalist." Most of our systematists have alternated between field and museum in a most constructive way. Thus our best systematists have always thought of a species as a group of living organisms set in an environmental framework. We must all now appreciate the fact that an individual animal is an almost inconceivably complex multidimensional organism, and not a bundle of systematic "characters."

The application of statistics to taxonomic studies is still new to me. This is in the direction of sound scientific method, and descriptions may thereby be made more exact and critical. Relatively new also is the evaluation of the systematic categories in the light of genetics, and the genetic study of variation, especially in connection with broad geographic trends. Some of these, like the Bergmann Rule and the Allen Rule, or the latitudinal relations of the number of vertebrae in fishes, are by no means new; but the appreciation of their relations to systematics is new, and the Huxleyan concepts for them of the cline and the step-cline are constructive and require our attention.

Thus for the "New Systematics" the student will require, in addition to his older equipment, an understanding of genetics, and specifically of population genetics, and an understanding of statistical analysis and its use in sharpening our systematic definitions.

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3 Ernst Mayr, *op. cit.*

Let me return to the old systematics for the moment to remind you what a glorious time we have had with both faunal papers and revisionary studies of genera and families. At its most elementary level, the "local list" may seem a trivial contribution to science, and indeed it is. The value of such lists lies in the fact that they accumulate for an eventual synthesis. As one of your editors of COPEIA, I value them highly as a means of training for the beginner, and as preliminary exercises in zoogeographic studies they need not be scorned by the most advanced professional.

As for the more comprehensive revisionary studies, the series of revisions of groups undertaken in this country under the guidance or patronage of Stejneger, Barbour, Ruthven, Blanchard, and others, have been sound contributions to science. They stack up well with the mine run of experimental university research, and lend themselves also, we hope, to the ultimate synthesis into the great faunas of North America, and of the world, to which I shall allude again. We are fortunate indeed to have interesting studies of this kind remaining to be done, and to be done better in the future. In turning to the new systematics, I do not wish unduly to decry the old.

THE NEW ANATOMY

Anatomy is intimately allied to systematics, and vital to any continuing revision of the higher categories of the classification. I have mentioned the neglect of descriptive and comparative anatomy during the past generation; I am happy to report news of great significance in this field. In comparative biological anatomy, otherwise comparative functional anatomy, the study of mechanism replaces the search for evolutionary relict structures, and a hand is seen to be as interesting as the notochord. Analogy is regarded as equally interesting with homology, driving the anatomist from his dissecting laboratory to the field or to the zoo to study the behavior of the living animal and the operation of its mechanisms, and thus infusing needed life into a subject too long thought moribund. It is almost startling to learn of the inadequate state in which descriptive anatomy was left at the turn of the century by biologists in search of greener pastures. For any survey of the anatomy of the genera and families of mammals that might be useful to a new systematics of the higher categories, it is essential to engage on new dissections. The only accurately described mammal, not excepting the cat, is man; and there is no comprehensive classic description of any reptile.

Mr. D. Dwight Davis of our staff at the Chicago Natural History Museum, has prepared for his own use a translation of Böker's "Biologische Vergleichende Anatomie." I regard it as a major sign that in ornithology, which is taxonomically so mature a field, Dr. Alden H. Miller, in California, has turned to this fruitful direction, in which careful studies of bird behavior and bird habits in the field are illuminated by studies of bird anatomy in the laboratory. Functional anatomy is by no means intrinsically a new field, but the attitude toward it is new, and the idea of an expedition to Brazil to study anatomy is still novel in most anatomical circles. The more old-fashioned descriptive and comparative anatomy still urgently needed to round out our basic zoological foundations cannot fail to be reassessed and infused with activity and with renewed interest by the insights of functional anatomy, and especially of comparative functional anatomy.

The New Natural History

Turning to my third main heading "The New Natural History," let me point out first the essential role of the "Old Natural History." This was the attempt to make known to the general public a summary of the results of descriptive zoology, unfortunately too often neglecting the fact that descriptive botany also belongs to natural history. The modern history of such comprehensive natural histories begins in the eighteenth century in France, and finds its most typical nineteenth century development in the successive editions of the German Brehm's 'Tierleben.' This noble work has had its illustrations pirated in successions of English natural histories, such as those of Wood, Kingsbury, and Lydekker. It is clear in all of these popular natural histories that some interest must be infused into them by accounts of the habits of animals, their relations to their habitat, and of their distribution. Indeed, it has been understood from the beginning that a naturalist is one who takes an interest in the living animal and reports upon it in its native environment.

How totally unscientific such a natural history may be is perhaps most clearly seen by reference to the still older works of the Roman Pliny and of his successors in the era of the Renaissance, in which mythical animals and myths about real ones are inextricably confused with truth. A perusal of the animal stories given wide circulation by the *Reader's Digest* in our own day discloses an unfortunate modern return toward Plinian natural history.

In the modern rejuvenation, if not reincarnation, of natural history as ecology and comparative psychology, I discern the means of infusing a wholly new spirit of accuracy into natural history. Control of observation by repetition and experiment and the inculcation of the basically scientific critical attitude will work as great a revolution in natural history as have genetics and statistics in taxonomy.

How great the need is for naturalists of the old school, merely made cautious by the new sciences, is shown by the fact that there is no English counterpart of the thirteen volumes of the last edition of Brehm's 'Tierleben,' and that this is itself now more than thirty years old. Such synthetic works have a vast influence in the whole scheme of education, not merely in biology, and some plea for funds and effort turned in this direction is in order. The ten volumes of the more scientifically planned Cambridge Natural History, the only readily available survey of the animal kingdom in English, are even older. The newer German survey, the Kükenthal 'Handbuch der Zoologie', is not accessible to many Americans. With the war's impoverishment of all Europe, including Great Britain, it becomes the plain duty of Americans to take over this general field of synthetic hand books and natural histories. Here is a major project for naturalists for the next generation and indeed for the remainder of the twentieth century. I may point out that an urgent need for success in this field is the spirit of cooperative effort. A work of this kind prepared in answer to the demand that arose during the war is the Pacific World Series; and I am happy to have had a share in this work, inadequate as it is. A new natural history, of the scope and calibre of Brehm, should reflect something of the new systematics and the new anatomy of

which I have spoken, and aid us in securing recruits for the endless problems of outdoor natural history that we propose to unlock with the keys of ecology and animal behavior. For the general field of animal geography, which grows more directly of all out of systematic studies, an ecological review of the environments of the world is as essential a preliminary as is a sound taxonomy of the Animal Kingdom.

There has been some affectation of contempt for ecology on the part of systematists, and I am free to admit that there is much ecological work in print that is downright bad. I have heard such ecology deservedly referred to as "the painful elaboration of the obvious." My own definition of ecology coined to characterize one of its worst phases is "that biological science in which a spade is termed a geotome." Good ecology on the one hand undertakes the critical observation of the total environment, and, with the basis of sound systematics, examines the habits of plants and animals in their environment; on the other hand, ecology picks up the populational concept of the species, studies the fluctuations and variations of populations, and examines their organization into societies and communities, attending to the spacial, temporal, and inter-organismic factors. Let me say that in this field icthyologists have made major advances, and that in general some of my remarks are appropriate only to the herpetological section of my audience. Let me particularly emphasize the curious fact that ecologists have tended to neglect evolution, and that the restoration of interest in evolutionary problems will form one of the most significant bonds between systematics and ecology. In calling upon you to be good ecologists, I mean that you are to be better naturalists, critical instead of uncritical, collectors only when and where collecting is essential, and learning to collect on a numerical basis.

Naturalists, in becoming more scientific in attitude, need not and should not lose their essential quality of an emotional enthusiasm toward natural phenomena. It is this that distinguishes the naturalist among scientists, and it is this quality of enthusiastic interest that makes naturalists the best of teachers and enables them to bridge the gap from the science of biology and the sciences in general to the non-scientific public. An appreciation of the humanistic values of science is an urgent need for the era of atomic energy.

It is my hope that the new systematics and the new anatomy will both contribute to the new synthetic science of ecology; and I hope most of all that many systematists, anatomists, and ecologists may continue to deserve the aura of meanings combined in the old term naturalist. May I illustrate my meaning with a paraphrase of the famous soliloquy of Dr. Faustus? You will remember that the learned doctor is speaking alone in his laboratory and at night:

> At least I am a scholar, ev'n with capital S,
> I've studied the Humanities, and now the Sciences as well,
> I've read the Law, and turned the barren pages of Theology,
> And bound the whole with something of Philosophy.
> With strings of letters to my name,
> And now with pupils of my own,

What most I've learned is but to know
What narrow limits frame the human mind.
This does not now assuage my knowledge-thirst;
While superstition's burden I have shed,
With it my confidence is lost;
I cannot feel that what I teach is true
Or that my teaching might convert
My fellowman to better ways;
Nor have I wealth or honor among men,
The daily press lampoons my kind;
Where shall I turn? What shall I do? . . .

Here in my book-lined office, where the desk is paper-strewn,
Need there be question why my heart
Beats anxious in my straitened breast?
Here I'm surrounded by the past,
With its dead books and skeletons,
And miss that web of living nature, into which
Mankind was set by God.
And thus I turn to Physiology
Asking new questions,
To see if the experimental key,
May open doors with distant glimpse
Of that reality for which I search—
The inner core of striving life,
Its change, its growth, its age-long evolutionary quest.—

And then I turn to the vast web of life itself
To search the tangled skein for threads
That lead to understandings, while the search itself
Takes me to field and forest, where, beneath the skies,
I hear the thrushes' liquid note,
And see the heron's arrow flight;
I'm caught within the season's flow;
My quest has carried me from pine to palm, and if I will,
I bathe my breast in roseate dawns.

Chicago Natural History Museum, Chicago 5, Illinois.

Feeding Habits of the Pacific Rattlesnake

By Henry S. Fitch and Howard Twining

During 1938 and 1939 we had an opportunity to study the feeding habits of the Pacific rattlesnake, *Crotalus viridis oreganus* (Holbrook), at the San Joaquin Experimental Range near O'Neals, Madera County, California. Other wildlife and range management studies in progress at the same time supplied information on populations and seasonal behavior of many plant and animal species. As part of a general program for wildlife studies on range lands of the Sierra Nevada foothills, this work was directed by Mr. Everett E. Horn, Biologist, of the U. S. Fish and Wildlife Service, in collaboration with the California Forest and Range Experiment Station. Jesse W. Nelson, Ben Glading, Charles A. Kaley, Freeman Swenson, and Raymond Sharp cooperated in securing data. Gathering of field data and examining of stomachs were done by Fitch; Twining aided in preparation of the manuscript and analyzed most of the scatological material, some of which was analyzed by John E. Chattin.

The animal life of the region is typical of the Upper Sonoran Life Zone in the blue oak and digger pine belt on the west flank of the Sierra Nevada. Eleven of the sixteen rodent and lagomorph species known to occur on the area were recorded in the food of the snakes. All these species vary in abundance on different parts of the Range, and are subject to fluctuations in numbers seasonally and over longer periods. The pocket gopher (*Thomomys bottae*) is the most generally abundant species, and may occur in populations up to twenty or more per acre over extensive areas. The ground squirrel (*Citellus beecheyi*), kangaroo rat (*Dipodomys heermanni*), woodrat (*Neotoma fuscipes*), white-footed mouse (*Peromyscus maniculatus*), rock mouse (*Peromyscus truei*), brush mouse (*Peromyscus boylii*), San Joaquin pocket mouse (*Perognathus inornatus*), and cottontail (*Sylvilagus auduboni*) generally are present in populations of one to many per acre. The meadow mouse (*Microtus californicus*), and the California pocket mouse (*Perognathus californicus*), are scarcer and more localized.

Those species not recorded among the food items are all relatively scarce, and the adult gray squirrel (*Sciurus griseus*), and jackrabbit are too large to be eaten by the Pacific rattler. The house mouse (*Mus musculus*) is here confined to the vicinity of buildings, where it is relatively safe from snakes. The harvest mouse (*Reithrodontomys megalotis*) is probably preyed upon but we obtained no records. The species is rare and localized here. The chipmunk (*Eutamias merriami*) was not recorded among the prey, and it is also one of the less common rodents.

Several kinds of lizards were recorded in the snakes' diet. The brown-shouldered lizard (*Uta stansburiana*), is the most abundant vertebrate species on the area, and the fence lizard (*Sceloporus occidentalis*) and whiptail (*Cnemidophorus tessellatus*) also are common. The alligator lizard (*Gerrhonotus multicarinatus*) and the horned toad (*Phrynosoma blainvillii*) are much less common, and neither was found among the food items. The spadefoot toad is abundant, and it is the only one of the seven amphibian species occurring locally that was preyed upon. It remains inactive

below ground throughout the summer and hence is readily available to the snakes only in spring.

In several instances actual field observations were made on the hunting and feeding behavior of rattlesnakes. Only four records of predation on birds were obtained. The two kinds of birds recorded among the prey items, the brown towhee (*Pipilo fuscus*), and California quail (*Lophortyx californica*), are both ground-living species frequenting thick cover where snakes are often concealed. On one occasion a flushed covey of quail consisting of parent birds and nearly grown young lit in thick brush, and immediately loud distress calls and fluttering were heard. The observer hurried to the spot and found a quail struggling feebly, anchored down by a large rattlesnake whose fangs were deeply imbedded high on one side of the quail's breast. In a few seconds the quail's head drooped and its breathing became convulsive; in four minutes its movements ceased and it appeared to be dead. Three and a half minutes later the snake released it and began nosing over the limp body, occasionally opening its mouth to grasp the quail hesitantly. These actions continued for about sixteen minutes; the snake was continually shifting its coils and moving over and around its prey, until finally it seized the head and began swallowing, backing away as it did so, and dragging the bird, which was thus kept stretched out full length with a minimum diameter to be swallowed. After six minutes of swallowing the head and neck had been engulfed, but the snake was having some difficulty in getting over the bend of the wing. The quail had been dragged in a circuitous course to a distance of about three feet, and half way back again. At this stage the observer interrupted by catching the snake. On another occasion a large rattlesnake was found beside a towhee which had been bitten in the leg and then partially swallowed. Retention of the hold at the time a bite is delivered may be characteristic in dealing with birds, which would fly and escape if released, but all rodents seen to be bitten were immediately released by the snakes, which waited for death of the prey before tracking it down. A rodent held by the snake might retaliate with a bite and inflict serious injury.

On two different occasions the actual striking of a squirrel by a rattlesnake was seen in the field. In one observation, recorded by Raymond Sharp, the squirrel jumped from an overhanging flat rock and was struck by a snake which had been lying coiled beneath. The squirrel was hit in the left shoulder, and ran about erratically bumping into objects in its path, then lay down with its sides jerking convulsively and its eyes shut. Four minutes later when the observer approached, it escaped into a burrow entrance, reeling about and falling on its side as it moved. Another instance was observed when a young squirrel running to its burrow in alarm, passed near a large rattlesnake, which lashed out and struck it broadside, and was jerked out full length before it could disengage its fangs. The squirrel squealed and scurried into its hole but probably it died soon afterwards.

Many animals bitten by rattlesnakes are not eaten by them, and the snakes are much less inclined to rattle in the presence of small animals than in the presence of man or large animals which might trample them, causing death or injury. Rather, when approached by a rodent, the snake is apt to strike without warning. The bitten animal may be too large to be swal-

lowed, or it may run too far for the snake to follow or may die in some inaccessible place, or the snake may not be sufficiently hungry even to attempt trailing it. The number of prey animals killed in this way but not used perhaps exceeds the number actually eaten.

In a number of instances rattlesnakes seen hunting in the vicinity of burrow systems where there were litters of small and inexperienced young ground squirrels were believed to have bitten several within a short time. One such occasion illustrating in detail the behavior of squirrels and snake toward each other was recorded on June 10, 1938, when the observer's attention was attracted by the shrill distress squeal of a squirrel, which then appeared, reeling about unsteadily on a burrow mound, holding its head sidewise, and pawing the right side of its face. This was at 6:57 P.M. Another small squirrel, probably of the same litter, but uninjured, came up beside the first one, and appearing very nervous, sat on the summit of the mound with its hair fluffed out, and twice within five minutes it gave long, vibrating chirps. The first squirrel became more quiet, sitting in a hunched position, but occasionally it toppled over sidewise or backwards, righting itself unsteadily each time until it had moved down to the lower edge of the mound. The uninjured squirrel moved slowly and cautiously off the mound, and away through the grass to another burrow. It stopped and chirped, looking into the hole, and then entered hesitantly. At 7:05 P.M., a third squirrel was noticed behaving like the first one and apparently similarly injured; it was crawling feebly and unsteadily under the edge of a boulder, about twenty feet from the mound where the other two were first seen. At 7:10 P.M., a three-foot rattlesnake emerged from the burrow and crawled slowly over the mound where the young squirrels had been. Obviously in search of prey, it was darting out its tongue continually, nosing over the ground from side to side apparently trying to pick up a scent. It moved over and around the mound, passing within a foot of the afflicted squirrel, which was still sitting in the same hunched position, but apparently the snake did not notice it. The squirrel had become lethargic, and did not notice the snake either. An adult squirrel had been perched on a rock about thirty feet away, giving the low musical chirps used by mother squirrels to warn their small and inexperienced young of approaching danger. This adult came hesitantly toward the place where the young had been, encircling the rock outcrop where the burrows were, and moving around the base of a boulder, it suddenly came face to face with the rattlesnake at a distance of about two feet. The squirrel emitted a sharp chirp and flicked its tail, and its hair fluffed out. The snake's body was extended so the squirrel was well beyond its striking range. For a moment it lay motionless, watching the squirrel, then it began to crawl slowly forward with its head and the anterior part of its body drawn back ready to strike. It seemed to be trying to get within reach but the squirrel edged away warily. The squirrel was aggressive, however, and would jump back, then take several quick steps toward the snake. Once it approached within a foot of the snake's head, and once scurried away in sudden fright, but quickly returned. It continually faced the snake and kept flicking its tail sidewise and giving low, vibrating chirps. The snake, without making any sudden movement,

followed it up over the sloping rock surface, but was not in a position to strike effectively. The squirrel, backing away up over the boulder, appeared to be exercising excellent judgment in keeping just beyond striking range; its movements were tense and cautious, and its attention was concentrated on the snake, so that for many minutes it failed to notice the observer. Finally it took alarm and ran to another rock outcrop. The snake crawled around to the burrow where it had emerged and disappeared. The uninjured young squirrel meanwhile had reappeared from the burrow it had entered, and moving in a hesitant, nervous fashion, flicking its tail and fluffing its fur, and chirping, it came to the injured squirrel and nosed it. Squirrel activity elsewhere had long since ceased, as darkness was rapidly setting in. At 7:25 it had left the vicinity of the home burrow and was hiding beneath a rock twenty feet a away, chirping at intervals; at last it came out again, and at 7:37 it disappeared into the burrow, but with apparent reluctance. At 7:40 it was almost too dark to see; the observer approached the injured squirrel and found it hunched against the base of the boulder with its eyes half closed, but suddenly it aroused itself and escaped into the burrow entrance. The snake could not be found. On the following day no squirrels were out in the vicinity of this burrow. The snake was not found either, but its tracks indicated that its movements had been much more extensive than those actually observed.

On another occasion, an unusually large rattlesnake seen coiled in a burrow entrance beside a dying young squirrel, appeared to have its body already distended with food. Still another encounter was observed when one of the writers was directed to a place where earlier in the day a young squirrel had been seen in the road, showing evidence of snake bite and evidently dying. This squirrel could not be located again, but two others in the vicinity ran to a rock outcrop, and one was moving erratically, seeming to be injured. The second, running among brush and rocks, was struck by a rattlesnake lying concealed there, and it died under a nearby boulder a few minutes later.

As the squirrel burrows are favorite hiding places for rattlesnakes, the squirrels are in constant danger of being bitten underground or in the burrow entrances. Although squirrels are alert and watchful for lurking snakes, accidents are frequent, and are most apt to happen when the squirrels are frightened to their burrows by some other danger and momentarily are off guard. Several such incidents were seen. Two young squirrels scared into the same hole when the observer approached popped out and back in again several times within a few seconds, and gave shrill squeals while underground. Then a small rattlesnake emerged from the hole, rattling and attempting to escape. Another time a large squirrel frightened into an apparently deserted burrow burst out again backwards and ran to another hole. Then a snake was heard rattling down in the burrow the squirrel had left.

Thirteen animals bitten by rattlesnakes were found dead in the field. Once a snake was caught in the act of swallowing a ground squirrel; in three instances the snake involved was lying beside the prey, another snake was seen to trail a kangaroo rat lying dead in the road, and after finding it dragged it for several yards to the shade of a bush and swallowed it. Two

other times snakes were located within a few feet of the freshly killed prey, which probably would have been found and eaten. Four ground squirrels and a meadow mouse all had been pierced in the thoracic or abdominal cavities by the bite; a brown towhee had been bitten in the leg. The other four prey animals had evidently been dead for some time and would not have been found by the snakes. Of these last prey animals, two ground squirrels and a kangaroo rat had only subcutaneous bites and probably died slowly; in another kangaroo rat the bite had penetrated the thoracic cavity, so death must have been almost immediate. Two other dead squirrels were found which had been swallowed and disgorged. On one occasion a squirrel and a rattlesnake were caught together in a box trap. When found the squirrel had been bitten in the thigh and axilla and it died in an hour and forty-five minutes.

Stomach contents were dissected from dead snakes and palped from live ones. Undoubtedly in the live snakes many well digested prey items that might have been revealed by dissection were overlooked because too much digested to be forced up by manipulation. Hence the ratio of snakes containing food among those examined was low—only 79 of the total number of 521. Seasonal distribution of feeding records was as follows: March, 3 (out of 36 examined); April, 22 (of 123); May, 26 (of 140); June, 14 (of 88); July, 10 (of 31); August, 2 (of 41); September, none (of 34); October, 1 (of 21); November, 1 (of 7). Snakes that have secured a meal in spring probably are able to subsist on it throughout the summer without feeding again, and still remain in good condition. Although less than one-fourth of the snakes recorded were adult females, this group includes 33 of the 79 that contained food. The feeding records for adult females were distributed seasonally as follows: March 1, April 12, May 15, June 5. During March, April, May and June, large adult females were found in a ratio of slightly less than two males to one female, but in July, August, September, and October, 34 males were found to only two females.

Evidently during the period of their pregnancy females remain in seclusion underground, and they must subsist largely on food taken in the spring during the breeding season. Among the snakes yielding food records, the high proportion of adult females in spring seems to indicate that they are then especially active in hunting.

Likewise nearly all feeding records for adult males were in April and May, although occasional adult males were found during the summer months. Feeding records for young were more evenly distributed seasonally than were those of adults, with nearly as many records for July (6) as for May (7) and June (7).

Small snakes, less than a year old, with head and body lengths less than eighteen inches and without more than three rattles had eaten one of the eight pocket gophers, one of the five kangaroo rats, six of the nine pocket mice, seven of the ten *Peromyscus*, two of the four fence lizards, both of the whiptails, the three brown-shouldered lizards, and both of the spadefoot toads.

Rabbits, ground squirrels, woodrats and quail are the main food of the large snakes. Gophers, kangaroo rats, meadow mice, larger lizards, and mice

are eaten mainly by middle-sized individuals, which likewise may occasionally take a small squirrel or rabbit, or any of the food items taken by the small snakes. Mice, small lizards, and spadefoot toads comprise the food of the smallest ones during the period when growth is most rapid. Size of prey is thus roughly proportional to size of the snake; in twenty recorded instances in which both the snake and its food were weighed, the prey was, on the average, 39.9 per cent of the snake's weight. The relatively largest prey item weighed 123 per cent of the weight of the snake that had eaten it. The prey item of relatively smallest size amounted to only 3½ per cent of the snake's weight.

All of the ground squirrels among the food items recorded, were immature individuals of the season's brood, and all were taken in April (9 records), May (10 records), June (3 records) and July (1 record). Though only young ground squirrels during the first few weeks after their emergence above ground are taken, they comprise about one-third of all food items recorded—more than twice the toll taken from any other species. "Mice," including six different species, about equalled the number of squirrels taken. All of the 23 squirrels were taken by adult snakes (head and body lengths of more than two feet). Nine of the ten rabbits taken and 20 of the 23 squirrels were eaten by large adult snakes with head and body lengths of more than 28 inches. Squirrels and rabbits thus comprised approximately 75 per cent of the items taken by snakes of this largest size group, which also ate gophers, woodrats, kangaroo rats, pocket mice, white-footed mice, and quail.

Of the 79 snakes that had food in their stomachs (or were found with their freshly killed prey), only four had more than a single food item. Two of these four contained young cottontails; in each instance the snake had found the helpless litter in the nest. Another contained a fence lizard and a pocket mouse, and a third had eaten two adult meadow mice.

Conditions favoring a high population of rattlesnakes probably could exist only in a habitat affording an abundance of several different prey species, which would provide adequate food sources for snakes of every size. Abundance of small rodents and lizards favors successful development of the smaller snakes. The area of the Experimental Range has relatively high populations of rat and squirrel-sized rodents, providing a food source for the larger snakes. But, compared with many other areas in the western states, its populations of lizards and mouse-sized rodents are low. Though several species are present, none is particularly abundant, and all are subject to marked fluctuations in numbers. Thus small rattlesnakes on this area are less well supplied with food than are adults, and a critical stage in the life cycle may occur during the first few months of life. During the late summer many young have been found in emaciated condition and we suspect that a high proportion of each season's brood dies before reaching the age of a year, partly through lack of sufficient food. Half-grown snakes with four, five, or six rattles are scarce as compared with adults or small young.

To our knowledge, the food habits of snakes have never been studied through examination of their fecal material, although this method has been widely applied in studying mammalian predators. Snake feces, or "scats,"

are easily identifiable, and samples obtained from caged snakes were used for comparison with those found in the field. A typical dropping consists of one or more dark-colored, elongated segments made up mainly of animal remains, accompanied by a mass of powdery white uric acid, which is often tinted with pink or green. The animal matter is so thoroughly digested that usually no bones remain. Hair is relatively unaffected, but teeth of rodents in the scats often fall to pieces when handled. Feathers and bills of birds are somewhat disintegrated but those found were sufficiently intact to be diagnostic.

TABLE I

COMPARISONS BETWEEN STOMACH AND SCATOLOGICAL EXAMINATIONS OF *Crotalus viridis oreganus*

Prey items	Stomach examinations		Scatological examinations	
	Number of prey items	Percentage of total	Number of prey items	Percentage of total
Citellus beecheyi	23	26.44	37	41.11
Thomomys bottae	8	9.20	2	2.22
Perognathus sp.	10	11.49	2	2.22
Dipodomys heermanni	5	5.75	24	26.67
Peromyscus sp.	10	11.49	4	4.44
Neotoma fuscipes	1	1.15	4	4.44
Microtus californicus	3	3.45	1	1.11
Unidentified mouse	0	0	2	2.22
Sylvilagus auduboni	14	16.09	3	3.33
Lophortyx californica	1	1.15	1	1.11
Pipilo fuscus	1	1.15	1	1.11
Eumeces gilberti	0	0	2	2.22
Uta stansburiana	3	3.45	2	2.22
Sceloporus occidentalis	4	4.60	3	3.33
Cnemidophorus tessellatus	2	2.30	2	2.22
Scaphiopus hammondii	2	2.30	0	0
Totals	87	100	90	100

Eight other species of snakes are known to occur on the area where our scat collection was made, but of these the night snake (*Hypsiglena ochrorhyncha*), the ring-necked snake (*Diadophis amabilis*), and the king snake (*Lampropeltis getulus*), are so rare that they need hardly be considered. The California racer (*Coluber lateralis*) is also much less common than the rattlesnake, and is limited to brushy areas different from the locations where scats were gathered. The garter snakes (*Thamnophis sirtalis* and *T. ordinoides*) are common on this range, but usually stay in the vicinity of water, and amphibians comprised all of the 83 items found in 25 garter snake stomachs. The gopher snake (*Pituophis catenifer*) is found in the same habitats where rattlesnakes occur, but is less numerous, in the ratio of about one gopher snake to five rattlesnakes. Possibly a small proportion of the scats collected are those of gopher snakes.

Most of the scats were picked up in the vicinity of squirrel burrow systems and rocky outcrops, locations in which rattlesnakes are apt to be

encountered. Several droppings were found below the surface of the ground in enlarged entrances of squirrel burrows, and it is probable that many others are deposited underground out of sight.

Many of the 90 scats examined contained two different kinds of prey. Remains identified and their associations were as follows: ground squirrel alone in 37; ground squirrel with kangaroo rat, ground squirrel with woodrat, ground squirrel with fence lizard, ground squirrel with whiptail lizard, each in one; kangaroo rat alone in 18; kangaroo rat with skink, kangaroo rat with fence lizard, kangaroo rat with whiptail lizard, each in one; kangaroo rat with brown-shouldered lizard, pocket gopher alone, pocket mouse alone, each in two; cottontail alone and woodrat alone each in three; white-footed mouse alone in four; meadow mouse alone, towhee alone, quail alone, unidentified rodent with fence lizard, unidentified rodent alone, and skink alone, each in one.

Since few of the snake stomachs examined contained more than one kind of food, the frequent occurrence of two prey species in one fecal mass suggests that the scats may ordinarily include the residues of more than one meal.

Trends shown by the scatological data and the stomach data differ most in the high percentages of squirrel and kangaroo rat and the relative scarcity of mouse and rabbit remains in the droppings. Most of the scats were those of larger snakes. Small snake scats may have been often overlooked in the field because of their resemblance to those of large lizards.

San Joaquin Experimental Range, California.

Notes on South Carolina Reptiles and Amphibians

By Carl B. Obrecht

During the summer of 1945, I had the opportunity to make herpetological collections and observations while engaged in malaria control work at Myrtle Beach Army Air Field, Horry County, South Carolina. Included with the following notes are a few records of specimens from the reptile collection at the Myrtle Beach Army Air Base Station Hospital. This collection has accumulated over a period of several years, unfortunately with little or no data. The specimens are, however, undoubtedly from the immediate vicinity of the Air Base.

The writer is indebted to Mrs. Helen Thompson Gaige and Dr. Norman Hartweg, of the Museum of Zoology, University of Michigan, for providing collecting equipment and for checking identifications, and to Douglas A. Patterson and E. O. Mellinger, at Myrtle Beach, for their aid in the field.

List of Species

Scaphiopus holbrookii holbrookii (Harlan).—Six specimens were collected in rain pools on July 11 along with *Gastrophryne carolinensis*. All appeared to be breeding adults. They were found in great numbers, both in open, unprotected areas and in ditches at the edge of the woods. Flooded ditches held the greatest numbers, where they could be seen along the banks among sedges, and in the water, floating down midstream. From this date until late September they could be heard throughout the area, immediately following any heavy rain.

Bufo terrestris (Bonnaterre).—The most abundant toad in the area. Five specimens were collected during the season at the Air Base.

Hyla versicolor versicolor Le Conte.—Following a period of excessive rainfall, a single specimen was taken, at night, from a low tree behind the Station Hospital. This specimen was located by its distinctive call, which was quite like that of more northern representatives.

Hyla femoralis Latreille.—Three specimens were collected in short grass along the edges of wooded ditches at the Air Base, where great numbers of this species engaged in a loud chorus, on the evening of July 7, following a heavy downpour. One specimen was collected on May 22, before the onset of the breeding season.

Hyla cinerea cinerea (Schneider).—A single specimen was collected near the Station Hospital on May 22, in a ditch along with *Hyla femoralis*.

Hyla squirella Latreille.—Five were taken at the Air Base during the summer. Three were collected from pyramidal mosquito resting stations located in the edge of deep woods, and two were found in New Jersey type mosquito light traps. This species is quite common throughout the area.

Rana catesbeiana Shaw.—The unmistakable booming voice of an adult of this species was heard only once, in the early part of the summer. No specimens were collected.

Rana clamitans Latreille.—A single very dark colored specimen was taken from Kingston Lake, about one and one-half miles east of Conway, on June 10. This specimen was found along heavily cypress-forested banks in deep shade, where the soil is a black, soggy loam. Aside from a small amount of brilliant green about the maxillaries, and dusky underparts, this frog was nearly the same color as the muck on which he was found.

Rana pipiens sphenocephala (Cope).—A species abundant along streams, ponds, and ditches throughout Horry County. The four specimens collected, as well as all others seen in the region, were conspicuously marked with large areas of iridescent green, and each with a clearly defined light spot in the center of the tympanum. In accordance with Stejneger and Barbour's check list these specimens have been designated as *sphenocephala*.

Gastrophryne carolinensis (Holbrook).—On the night of July 11, during a period of exceptionally heavy rains, great numbers of this species appeared in rain pools all over the Air Base. Their high-pitched screams, mingled with harsh, throaty croaks of countless *Scaphiopus*, set up a terrific din. Two specimens were collected. On June 15, I had taken a single specimen from under a board beside a rain pool, in an open, grassy area.

Anolis carolinensis Voigt.—Although quite common in northeastern South Carolina, only one specimen was collected at the Air Base, September 8. This species is most frequently seen sunning itself among herbaceous plants bordering streams and ponds.

Ophisaurus ventralis (Linnaeus).—Early in October I saw a single, large adult of this species crossing a path in an open, dune-grass section of Myrtle Beach State Park.

Cnemidophorus sexlineatus (Linnaeus).—Several adults were seen on the edge of woods and in open fields, but I was unable to secure a specimen.

Eumeces fasciatus (Linnaeus).—One large, adult specimen is represented in the Station Hospital collection. Several others were seen in dense woods during the summer.

Diadophis punctatus punctatus (Linnaeus).—One specimen was discovered under a decaying log on the edge of woods at the Air Base.

Heterodon contortrix contortrix (Linnaeus).—This species is very common in this area. Two specimens were collected from Horry County, one from the Air Base, and the other from Myrtle Beach village.

Opheodrys aestivus (Linnaeus).—One large specimen was seen high among the leaves of a young sassafras. The specimen was captured but later escaped. The Station Hospital collection contains a large adult, 85 centimeters total length.

Coluber constrictor constrictor (Linnaeus).—This is one of the most common snakes in the region. They are quite frequently found among tall grasses of the coastal dune region at Myrtle Beach State Park, where one specimen was collected on May 24.

Masticophis flagellum flagellum (Shaw).—This species is also rather common. Two large specimens were collected, one of which was found DOR, and the other, a beautiful adult 165 centimeters in length, was brought to me by the Base Sanitary Engineer. Both were taken from the Air Base.

Elaphe guttata (Linnaeus).—A specimen 51.4 centimeters long was removed, in excellent condition, from the stomach of *Micrurus fulvius*. One adult specimen is in the Station Hospital collection.

Rhadinaea flavilata (Cope).—One specimen, total length 27.3 centimeters, was found under a decaying log in moist, shaded woods at Myrtle Beach State Park, on May 23.

Cemophora coccinea (Blumenbach).—A single specimen with no data other than Horry County, was brought in on July 1, during my absence.

Natrix sipedon fasciata (Linnaeus).—One specimen was snared from a partially submerged cypress branch at Kingston Lake near Conway, on June 10. Several were seen in this cypress swamp lake but were not captured.

Natrix taxispilota (Holbrook).—This snake frequents the cypress knees and overhanging branches along the tidal rivers of the region. Two were snared from a boat on the lower, brackish waters of the Waccamaw River, Georgetown County, about three miles from Pawley's Island, on July 8.

Storeria occipitomaculata occipitomaculata (Storer).—A specimen was brought to the Station Hospital on July 10, with only the information that the specimen came from "around the Air Base."

Thamnophis sirtalis sirtalis (Linnaeus).—One specimen was found on the

sandy floor of a mixed conifer-hardwood forest near the Station Hospital.

Micrurus fulvius fulvius (Linnaeus).—A large specimen was collected at Myrtle Beach by Mrs. Malcolm Ormsbee, October 21. This individual measured 74.3 centimeters in length. When opened for preservation, a young *Elaphe guttata,* 51.4 centimeters long, was removed from the stomach. A second *Micrurus,* nearly as large, was brought to the Station Hospital and retained for the dispensary collection.

Agkistrodon mokeson austrinus Gloyd and Conant.—This species is the commonest and most dangerous of the poisonous snakes in this region. One young specimen was taken at night beside a drainage ditch in a heavily wooded area of the post reservation. Others were seen in similar situations, in the water of these ditches, and while they were crossing open areas. Two persons bitten by this species were admitted to the Station Hospital, during my assignment there, one of the victims a German prisoner-of-war, and the other, a civilian who resided nearby. Neither of the cases was fatal. It appears that the copperhead must account for the greatest number of snakebite cases in this locality.

Agkistrodon piscivorous piscivorus (Linnaeus).—This species is represented only by a juvenile specimen in the Station Hospital collection.

Sistrurus miliarius miliarius (Linnaeus).—A single adult specimen may be found in the Station Hospital collection. From all reports, this seems to be a species rare in this region.

Crotalus horridus atricaudatus (Latreille).—Although the species is said to be found quite frequently in this part of the state, I was unable to secure a specimen. One large adult was brought to the Station Hospital during September and reserved for the dispensary collection.

Kinosternon subrubrum subrubrum (Lacépède).—This was the only turtle collected. Three specimens were taken in ditches around the Air Base. One of these appeared to be recently hatched, and was found among aquatic vegetation in a ditch on June 15.

Alligator mississipiensis (Daudin).—Alligators are common in this area. They frequent sluggish and brackish streams, and coastal marshes, where they are said to attain a length of six feet or more. There is evidence of some breeding, as several old nests were found in tidal marshes. A fresh nest in this situation was uncovered by laborers, yielding many young, but I had no opportunity to obtain them for the collection.

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Observations on the Burrowing Behavior of the Hog-Nosed Snake

By D. Dwight Davis

THE hog-nosed snakes, of the genus *Heterdon,* are noted for the shovel-like development of the rostral region that distinguishes them from all other snakes in the United States. This striking morphological condition seems to have aroused small interest among herpetologists, however, and little has appeared on its relation to the habits of the animal. Hay (1892: 512–13) was one of the few whose curiosity was aroused by the highly modified snout: "What is the use of the sharp-edged, pointed snout? Is it used in burrowing? Or is it employed in rooting up the ground in search of insects and other food?"

Apparently unknown to Hay these questions had been partly answered some years earlier. That delightful chronicler of nature, Charles C. Abbott, wrote of *Heterodon contortrix* (1884: 289) that he had "found them partial to loose, sandy soils, as in cultivated fields, in which they burrow with all the facility of a mole. They burrow, I am led to believe, only to a shallow depth, and think it is in search of earth worms and insect larvae, and not merely for the sake of shelter. In several instances, where I have detected them coming out of the ground, I have found in their stomachs semi-digested animal matter which were believed to be the remains of earthworms and insect larvae." Surface (1906: 182) ventured the opinion that the modified rostral "is doubtless used by the serpent in boring into the ground to find a suitable place for bringing forth its young, or passing a dry or cold season." These few lines appear to be about all that is known of the burrowing behavior of the members of this genus.

In order to observe in detail the method used by these snakes in burrowing, a number of individuals were brought into the laboratory and observed under various conditions. The observations given below were made on one of two specimens of *Heterodon contortrix* from Union County, Illinois, but the behavior is typical of others brought in from various sources and observed from time to time.

The snakes, a twenty-three inch male and a female three inches shorter, were released in a box containing six inches of fine, dry sand. The initial movements of both snakes were directed solely toward escape. They ranged freely about the box, seeking a means of escape. Shortly after being released the female flattened her head and neck, apparently without provocation. She crawled about in this attitude for about 15 seconds.

Ten minutes later, at 4:25 P.M., the male began to burrow voluntarily. The beginning of the process was not witnessed. Three minutes later the partly buried snake was pulled out and the sand smoothed over. The following excerpts from notes made at the time show what is probably approximately the normal burrowing behavior of this species.

4:29 P.M.: The snake was returned to the box. It slid its head along the sand with the rostral region just below the surface. The head was bent slightly downward at the articulation with the neck. The head disappeared

completely under the sand, then reappeared shortly. This movement was produced solely by a continuous thrust from the body. There was no independent movement of the head. Suddenly striking at a deeper angle, estimated at about 30°, it began to burrow actively. The head, bent sharply downward, was moved actively and alternately from side to side. In two minutes the body was more than half buried, and the snake was still burrowing slowly.

4:34 P.M.: The snake was still active, but did not seem to be moving deeper into the sand. The exposed part of the body was tapped lightly, which caused the snake to burrow rapidly. In 10 seconds it was completely under the sand.

The snake was exhumed and the sand clinging to it brushed off. When dug out, the head was found on the bottom of the box with the body in the sand above. It was returned to the box, where it moved about actively for several minutes.

4:44 P.M.: The snake moved the length of the box with the head plowing just beneath the surface of the sand, but not deeply enough to cover it completely. This was again a direct forward thrust, without lateral movement. After crawling the length of the box twice in this manner, the snake depressed its head more sharply and started to burrow. Rapid, alternate lateral thrusts of the head were used. After burrowing for two inches a short distance beneath the surface, the head was suddenly driven deeper and the body drawn after it. During this active burrowing there was considerable peristaltic movement of the body. Successive waves of powerful muscular contraction passed back from the head. At 4:48 the snake was still active, and only the posterior third of the body remained above the surface. The head was apparently performing exploratory movements, since activity was evident, but there was no further downward movement.

4:45 P.M.: The snake was still active intermittently, but five inches of the body remained on the surface. This was being drawn under about half an inch at a time, with more or less regular movements spaced a few seconds apart. At 4:58 only an inch of the end of the tail was visible. Movements of the body had become progressively slower.

5:00 P.M. The snake curled its tail into the hole, thus disappearing completely. A smooth hole, slightly larger than the diameter of the snake's body, remained in the sand. The time required for complete burial in dry sand was therefore fifteen minutes.

The snake was exhumed and the sand smoothed over. When the observer left for the night it was active on the surface of the sand. The next morning the snake was buried. The hole through which it had disappeared was in a corner of the box. The snake was found coiled loosely on the bottom of the box, directly beneath the hole.

Burial took place so quickly in dry sand that it was impossible to observe in detail the movements by which it was accomplished. In order to offer a more resistent medium, the top two inches of the sand was thoroughly dampened. The snake was then released in the box for further observation.

After several unsuccessful attempts to move the wet sand the snake refused to burrow voluntarily. It was teased by tapping it lightly on the head

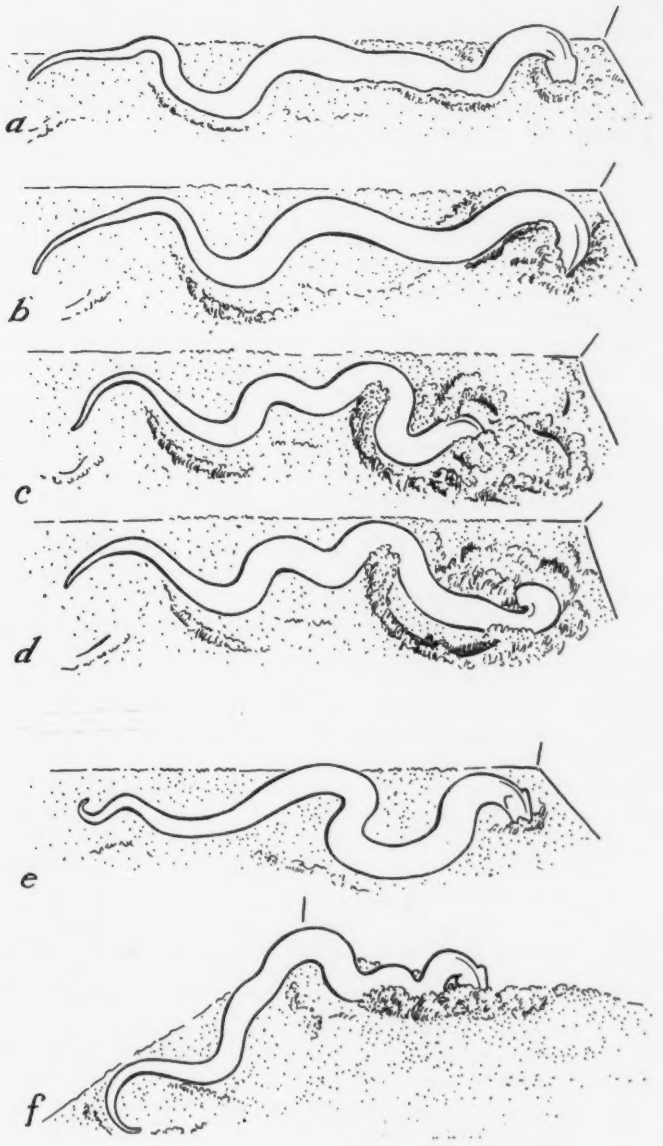

FIGURE I

Positions assumed by *Heterodon contortrix* while attempting to burrow in damp sand. Tracings made from photographs. a-d, successive positions of same individual; e-f, to show angle of head when striking into sand.

and body with a stick. After considerable head-flattening, blowing, and attempted flight, it began to burrow *as an escape reaction*. The snake was unable to excavate the wet sand effectively, so that burrowing movements could be observed with ease. The head is depressed sharply at its articulation with the body. This flexure causes the ends of the quadrate bones to stand out prominently. Their distal ends appear as a pair of conspicuous knobs at either side of the back of the head. The anterior two or three inches of the body is arched slightly, so that the dorsal surface of the head is almost vertical. The head is generally rotated slightly to the side on which the thrust is to be given. From this position it is thrust forward and laterally, and is usually rotated slightly dorsally. This rooting movement then takes place in the opposite direction, and is repeated alternately from one side to the other during burrowing (Fig. 1).

The position into which the head is drawn at the beginning of each thrust brings the sharp lateral edge of the rostral scute into direct contact with the substratum. During subsequent movements of the head, the wedge-shaped rostral region functions as a double-shared ridging plow, forcing its way through the substratum and pushing the sand to the side. The power for these vigorous movements is derived solely from the anterior dorsal axial musculature, which is enormously hypertrophied in the members of this genus.

The direct forward thrust of the head that is frequently observed in *Heterodon* is a movement quite distinct from actual burrowing. Its significance, if any, is not immediately apparent.

The question of the relation between burrowing and the bionomics of the hog-nosed snakes can be answered only after suitable field observations. These snakes are generally regarded as being partial to sandy habitats, but they are by no means confined to such situations. The food, as determined by Surface and others from analyses of stomach contents, consists largely of toads. Since toads are known to spend the day secreted in burrows, it is possible that *Heterodon* may burrow in search of them. Verification of this supposition can come only from careful field observation. The suggestion made by Surface that they burrow in connection with breeding habits or hibernation does not seem plausible, since other snakes with similar habits are not so modified.

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An Arm Protractor for the Precise Measurement of Angles in Systematic Ichthyology [1]

By Carl L. Hubbs

IT has been a common practice to describe the form and position of structures in fishes in terms that are almost meaningless to one who does not have a complete set of comparable specimens at hand. Thus one species has been distinguished from another by having a "sharp" instead of a "blunt" snout; or by a "moderately oblique" rather than a "subhorizontal" mouth; or by a "gradual" rather than an "abrupt" convergence of the posterior body contours. The addition of modifying adjectives has helped but little, for what is "slight" to one may be "moderate" to another. Even when one specifies, for example, that the angle of the disk margin is less than a right angle in one skate and more than a right angle in another species, the data do not admit of statistical analysis.

It has been found possible to obtain a quantitative expression of differences in body form with an acceptable degree of precision and consistency by the determination of angles. By such measurements descriptions have been rendered more meaningful and comparisons have been made much more definite. Thus the greater obliquity of the mouth in *Notropis altipinnis* as compared with *N. scepticus* has been expressed by measuring the angle between the edge of the premaxillary and the line approximately tangential to the top of the profile of the head (Hubbs, 1941: 171). In *N. altipinnis* the angle, as measured in 20 specimens, varied from 63 to 76°, whereas in 19 examples of *N. scepticus* the angle was 56 to 65°. For 3 lots of the respective species the averages ranged from 65.4 to 69.4° and from 56.5 to 61.1°. The angle between the dorsal and ventral contours of the head was found to vary from 38 to 42° (average, 39°) in *Fundulus heteroclitus macrolepidotus* and from 31 to 36° (average, 33°) in *Fundulus diaphanus diaphanus*. In a hybrid the angle was 36°, giving this specimen a hybrid index of 45 in respect to the sharpness of the head (Hubbs, Walker and Johnson, 1943: 7). For defining by angles the general form of the body other methods have been used, for example by Storey (1938: 6–7).

At first such angles were measured by using a protractor with a piece of thread. Later an "Arm Protractor and Goniometer" was found on the market, but the protractor was printed on opaque paper and the arm was too short. Finally it became obvious that a more serviceable type of instrument should be custom-built for the particular purpose. Consequently, two arm protractors were recently made by the skillful hand of Carl I. Johnson for use by the fish biologists at Scripps Institution of Oceanography. The second one (Fig. 1) was constructed from a purchased celluloid protractor 8 inches in basal length and from a strip of "plexiglass." The protractor was trimmed to the base line of the printed scale and both edges of the "plexiglass" were machined to straight lines so that either side may be used. In the trimming small semicircles were left to receive the small adjustable brass bolt which is centered on the base and on the 90° vertical of the protractor scale.

Advantages of this instrument are its transparency, its easily read scale and the facility by which it may be adjusted with one hand while the other

1 Contribution from the Scripps Institution of Oceanography, New Series, No. 290.

hand holds the specimen in position. The long arm is serviceable when one measures such angles as that between the gape or a profile, and the longitudinal axis of the fish from the tip of the premaxillary to the center of the caudal base.

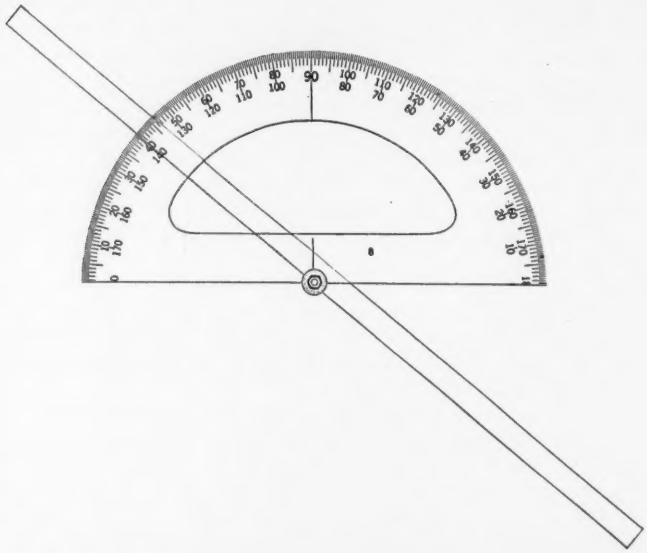

Fig. 1. Arm protractor for measurement of angles in systematic ichthyology. *Instrument made by Carl I. Johnson. Photograph by Paul Williams, retouched by Elizabeth M. Kampa.*

In a recent use of angles in the description and comparison of fishes the arm protracter was called "an instrument that should be in every ichthyologist's kit" (Hubbs, 1945: 130). It could prove valuable in some racial investigations by fishery biologists. Furthermore, the type of arm protractor that is figured may be found useful by herpetologists and by specialists in other branches of systematic zoology.

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Measurements of Some Pelagic Commercial Fishes of Hawaii

By Kelshaw Bonham

THE most important commercial fish in the Hawaiian Islands is the aku, *Katsuwonus pelamis* (Linnaeus), commonly known in other parts of the world as the striped bonito or skipjack. Before the war this species is said to have constituted 60 per cent of the Hawaiian deep sea landings, averaging about 7 million pounds a year. Since little is known concerning the biology of the aku, a study was begun in December, 1944, to determine age and rate of growth. The plan was to measure fish lengths in samples of the commercial catch throughout one year in the hope of finding in the length frequency curve, modes that might correspond to year classes. Although it was not possible to carry the problem to completion, the measurements made between December 9, 1944, and June 22, 1945, are here recorded.

Table I

Fork Lengths and Some Weights of the Mahimahi or Dolphin, *Coryphaena hippurus*, Caught from December, 1944, to June, 1945

Date	Length (cm.)	Weight (lbs.)	Date	Length (cm.)	Weight (lbs.)	Date	Length (cm.)	Weight (lbs.)
Dec. 30	85	10	Apr. 25	70	..	Apr. 25	86	..
Dec. 30	100	18	Apr. 25	71	..	Apr. 25	89	..
Dec. 30	106	19	Apr. 25	72	..	Apr. 25	95	..
Mar. 10	121	31	Apr. 25	72	..	Apr. 25	96	..
Apr. 11	59	..	Apr. 25	72	..	Apr. 25	100	..
Apr. 11	64	..	Apr. 25	73	..	Apr. 25	118	..
Apr. 11	64	..	Apr. 25	73	..	Apr. 25	131	
Apr. 11	65	..	Apr. 25	73	..	May 16	108	..
Apr. 11	66	..	Apr. 25	74	..	May 16	111	29
Apr. 11	68	..	Apr. 25	77	..	May 16	113	..
Apr. 11	71	..	Apr. 25	78	..	May 16	118	31
Apr. 11	126	36	Apr. 25	78	..	May 16	127	..
Apr. 14	68	..	Apr. 25	78	..	May 16	130	45
Apr. 14	84	11	Apr. 25	79	..	May 17	87	..
Apr. 25	63	..	Apr. 25	81	..	June 22	74	..
Apr. 25	67	..	Apr. 25	85	..	June 22	75	..
Apr. 25	69	..	..	..	..	..	..	..

The work was aided by the Fisheries Research Committee of the Territory of Hawaii which helped defray the cost of transportation. The officials and fishermen of the Hawaiian Tuna Packers Association were very cooperative in permitting the fish to be handled for measuring. More than 90 per cent of the fish in 26 landings were measured, totaling 4746 aku and 159 fish of other species; about half of those not measured had broken tails. Using a measuring board marked in half-centimeter intervals, caliper length to the fork of the tail was measured to the nearest half-centimeter by lightly pressing the snout of the fish against the upright and sighting the mark on the board most nearly directly beneath the tips of the shortest caudal rays. The fork lengths were recorded by an assistant in the field and tallied into frequencies later. In tallying, the lengths on the whole-centimeter mark were combined with those on the next greater half-centimeter mark to produce the

frequency based on whole-centimeter lengths as presented in Figure 1 and the tables. In order to be precise, the class mark should be one-fourth centimeter greater than is shown. For example, the 50 centimeter mark should be 50.25 centimeters in order to comply with the requirement that equal numbers of individuals within the centimeter class shall fall on either side of the interval mark.

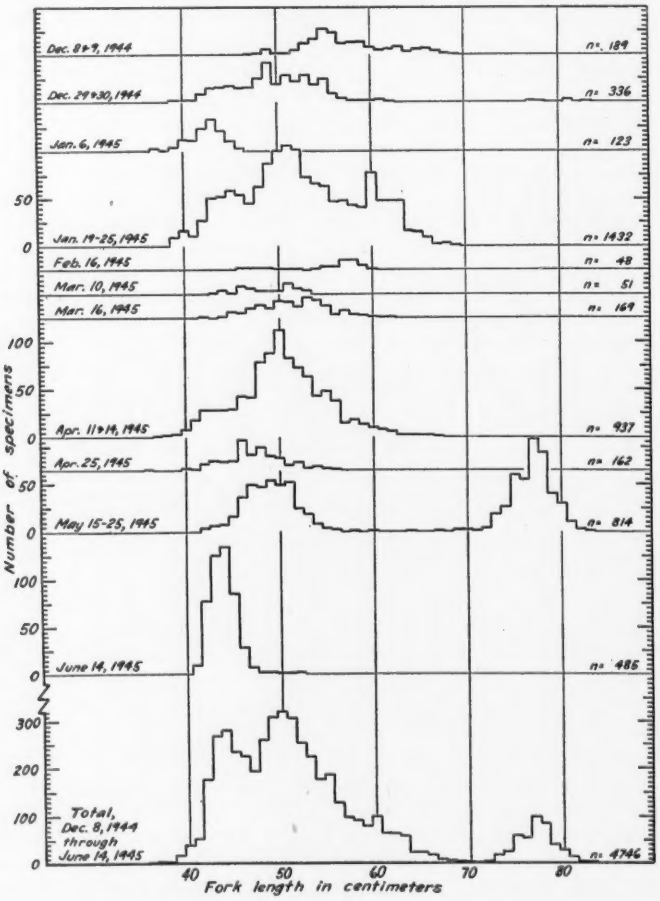

Fig. 1. Histograms showing semi-monthly length frequencies of aku, *Katsuwonus pelamis*, taken within 30 miles of the Island of Oahu.

The fish measured were taken by five 10-man sampan boats operated by the Hawaiian Tuna Packers Association. The fish were chummed with nehu (anchovies) if necessary, and caught with pole and line using a feathered, barbless hook. Although the boats range farther in ordinary times, these fish were caught within 30 miles of the Island of Oahu, some as close as one-

quarter mile. They were landed either at Honolulu or Kaneohe Bay, Oahu.

The bimodality of the aku length frequencies (Figure 1) near 50 and 80 centimeters at once suggests two adjacent year classes. However, an orderly progression of the lower mode toward the higher, to be expected during the six-months' period if these were successive year classes, is lacking. It was supposed that measuring the fish in a sufficient number of landings would subordinate the recognized factor of narrowly delimited size groups usually encountered in one landing when the trip had been short and only one or two schools had been fished. The relative scarcity of aku between 60 and 75 centimeters during the period from December to June, raises the question as to whether or not fish of this size had withdrawn from these fishing localities.

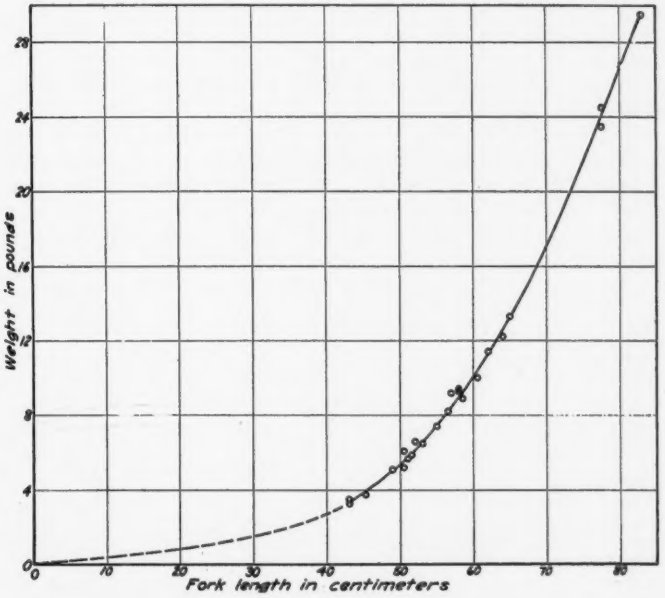

Fig. 2. Graph showing relationship of length to weight for 23 aku, *Katsuwonus pelamis*, taken between December 29, 1944, and January 25, 1945.

Possibly 60 centimeters represented an intermodal size between successive year classes. The latter assumption would imply an almost incredibly rapid growth in about two years to the approximate maximum size of 80 centimeters encountered in these landings. Further observations over an entire year would probably elucidate these problems.

Kishinouye (1923: 293–475) states that a 21-centimeter *Katsuwonus pelamis* taken in August at Okinawa-ken had presumably been hatched that spring, and that a specimen 30 centimeters without the caudal, taken in January near the Ogasawara Islands, was also probably a yearling.

Other fish landed with the aku, although few, were measured. A single kahala, *Seriola dumerili* (Risso), taken on May 25, measured 100 cm. An

ono or wahoo, *Acanthocybium solandri* (Cuvier), collected on June 22, was 123 cm. long. Kawakawa, *Euthynnus yaito* Kishinouye, were landed only on the trip of June 22, when no aku was caught. Their lengths (cm.) were as follows: 40, 49, 50, 56, 57, 64, 65, 67 (4 specimens), 69, 70 (2 specimens), 71 (2 specimens), 72, 75, and 78 (2 specimens). Measurements for the mahimahi or dolphin, *Coryphaena hippurus* Linnaeus, and the ahi or yellowfin tuna, *Neothunnus macropterus* (Schlegel), are given in Tables I and II, respectively.

TABLE II

FREQUENCY DISTRIBUTIONS OF FORK LENGTHS IN CENTIMETERS OF THE AHI OR YELLOWFIN TUNA, *Neothunnus macropterus*, CAUGHT DURING 1945

Length	Number of specimens			
	Mar. 16	May 16	May 25	June 22
50	.....	.....	.....	1
51	.....	.....	.....	2
52	.....	.....	.....	3
53	.....	.....	.....	2
54	.....	.....	.....	3
58	.....	.....	.....	1
61	2	1	.....	.....
62	1	.....	.....	.....
63	1	.....	.....	.....
64	6	.....	.....	.....
65	7	.....	.....	.....
67	1	.....	.....	.....
68	1	.....	.....	.....
69	.....	2	3	.....
70	.....	.....	5	.....
71	.....	1	7	.....
72	.....	1	13	.....
73	.....	.....	9	.....
74	.....	.....	6	.....
75	.....	.....	6	.....
76	.....	.....	2	.....
80	.....	.....	1	.....
Total	19	5	52	12

Figure 2 shows the length-weight relationship of 23 aku taken between December 29, 1944, and January 25, 1945.

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On the Reappearance of Melanophores in Blind Goldfish

By Priscilla Rasquin

Introduction

During the normal course of its life history the common commercial gold fish, *Carassius auratus* (Linnaeus), undergoes a change in pigmentation from the olive gray appearance to that of reddish yellow, which is due to a loss of melanophores in the skin and an increase in erythrophores and xanthophores. The time required for this transition to take place differs with the genetic constitution of each fish. All individuals do not turn yellow at the same age and some do not change at all. Once the yellow color has been attained, however, it remains unaltered throughout life except under certain experimental conditions where some investigators have reported the reappearance of melanin bearing pigment cells.

There is reported herewith a condition in which melanophores were found to develop in two blinded yellow goldfish many months after the operation, and the condition of melanophores found in an eyed yellow goldfish which had been kept in total darkness for a similar length of time. This is discussed in connection with its bearing on the problem of fish pigmentation and the reactions of melanophores which accompany vision or blindness and incidence of light or darkness.

The author is greatly indebted to Dr. C. M. Breder, Jr., for encouragement and criticism of the manuscript.

Experimental Results

In connection with another experiment, in August, 1944, a few goldfish were blinded by severing the optic nerves. These fish had reached the all-over yellow condition long before the operation. Two of these survived for several months and were maintained in laboratory aquaria subjected to temperatures of from 24° to 29° C. and normally recurring daylight and darkness. One fish that died in August, 1945, a year after the operation, showed conspicuous gray patches on the body and fins which had been evident for some months. The pigmentation covered approximately two-thirds of the body surface. The second goldfish lived a few months longer and at the time of its death showed a pigmented condition similar to the normal gray goldfish before it has become gold, i.e., an all-over olive gray appearance. The pigmentation reappeared on the body in the same manner in which it originally disappeared, gradually spreading dorsally from ventral and lateral surfaces. Whole mounts made of the skin of these fishes showed melanophores whose granules appeared in all stages from concentration to full dispersion. Similar preparations made of the skin and fins of the gray goldfish showed the melanophores in the same condition. No difference in morphology could be noted between the two. Whole mounts made of the skin and fins of a goldfish turning from gray to gold condition showed typical melanophores in the gray portions while the light portions showed no melanophores at all. The caudal fin, which was still gray, showed the typical pigment cells, while that portion of the pelvic fin that was light was perfectly clear. Only along the proximal part of the rays could pigment cells be seen and these appeared to have a

much less abundant granulation. Sections made from the skin of the goldfish which exhibited the reappearance of pigment showed the melanophores to be situated in both the dermis and epidermis. They appeared to be in good condition, no degenerating cells were found and no isolated granules or debris were seen in the tissue.

In September, 1944, two goldfish were placed in a container from which all light was excluded. They were kept in total darkness, the only light that was permitted to enter was that from a five Watt carbon ruby dark room bulb necessary at the time of feeding. Four and one-half months later one was removed from the dark tank and from a gross examination showed no black pigmentation. Sixteen months later the second fish when found dead was removed from the tank and carefully studied for pigmentation. Grossly the fish appeared to be without melanin but under the dissecting microscope a few fully contracted melanophores could be seen. Whole mounts made of the cleared skin confirmed the presence of these cells. Sections of the skin showed the melanophores to be located mainly in the epidermis although some few scattered cells could be seen in the dermis. This fish was in a ripe condition and evidently died from ovarian congestion. There was no evidence of malnutrition associated with its long sojourn in the dark.

In addition, 50 young cave fish, *Anoptichthys jordani* Hubbs and Innes, were operated on, 25 having the blind capsule removed and 25 having the optic nerves severed. These were maintained in laboratory aquaria under conditions similar to those of the blinded goldfish.

Discussion

The pigmentation of fishes and its reactions to light and dark has been a subject for experimentation over some considerable length of time. The work resolves itself into three separate divisions, one on eyed fish, one on experimentally blinded fish and one on cave fish which have lost their vision phylogenetically. Most fishes assume a light phase when placed on a light background and a dark phase when placed on a dark background; the extent of this change varies widely from one species to another. The sudden change in shade is due to the rearrangement of pigment in existing cells rather than to the formation of new melanophores or loss of old, which processes follow more slowly (Sumner and Wells, 1933). It has also been found that melanophores can be made to develop on surfaces which ordinarily contain no such cells such as the whitish ventrum of some fishes. This follows if certain conditions are satisfied, namely that the surface be subjected to direct illumination and animal kept in the dark phase by permitting its eyes to be exposed to a dark surface, thus keeping the melanophores of the dorsal region expanded. In other words, the granules of the melanophores must be in a dispersed condition in order to further their increase in numbers. Thus Osborn (1940 and 1941a) was able to demonstrate the growth of melanophores on the normally unpigmented under surface of the flounder, *Paralichthys dentatus* (Linnaeus), by keeping the animals in a dark-colored tank illuminated only from below through a glass bottom. These pigment cells were found to develop in situ from potential melanophores as demonstrated by the "dopa" reaction. In the same manner he was able to grow melanophores on the white ventral surface of the catfish, *Ameiurus melas*

(Rafinesque), and at the same time he also demonstrated the necessity for the presence of the secretion of the pars intermedia of the pituitary. Blinded hypophysectomized catfish lost much of their pigmentation.

That such potential melanophores or melanoblasts exist in the normally unpigmented areas of the skin in fishes is presumably shown in the reversal of coloration in some flounders (Gudger, 1945), where the pigmentation is on the ventral instead of the dorsal surface or on both. Some factor other than the incidence of light must be at work in these cases for conditions of life on the ocean floor cannot offer any situation similar to Osborn's experimental conditions. Aberrant coloration is not rare in several species of these fishes, in the development of which one eye migrates to the other side. It is interesting to speculate on whether or not some stress or strain accompanying such migration disrupted the medulla oblongata in some way so that a distortion in the laying down of the pigment pattern resulted.

The production of melanophores on a normally unpigmented surface has been observed as a response to agents other than light. Fukui (1927) claimed that pigmentation returned to the surfaces of yellow goldfish as winter approached, i.e., as the temperature decreased. He also reported being able to induce the recurrence of melanophores in the goldfish by subjecting them to weak solutions of sodium chloride and calcium chloride and by repeated injections of adrenalin.

Smith (1931) reported the appearance of melanophores in traumatic injuries inflicted on yellow goldfish, "in the wound itself, in adjacent areas and sometimes in remote cutaneous areas." The same author (1932) demonstrated the reappearance of melanophores at the site of the exposure after submitting goldfish to X-rays. Ellinger (1939 and 1940) also demonstrated melanophores in the goldfish after using X-rays, the pigmentation starting in the head region and proceeding posteriorly, and claimed that up to 28 days after the irradiation the pigment had not started to disappear. Smith's goldfish eventually lost their pigmentation, but Ellinger's fish were not in good health after experimentation and presumably did not live long enough to permit a possible depigmentation process to appear. However, Ellinger autopsied his fish and found that all the lymphoid tissues were atrophied and that a good deal of fibrosis had occurred in these tissues. Moreover, the brains of these irradiated fish were also studied and fibrosis was found in the region of the medulla oblongata, formed by the growth of the glia fibers. Ellinger suggests that this may explain the growth of pigment not only in the sites of exposure but all over the innervated surface of the body, since the pigment cells are controlled from a center in the medulla. He also suggests that a process of depigmentation could not occur since the destruction of this regulatory center prohibited its regeneration, and a recontrol of the pigmentary responses could not be established. These are the only manifestations of a permanent character, for the dark-adapted fish returns to its original condition when replaced in the light and the melanophores caused by wounding and non-lethal doses of X-ray also disappear in time.

Fishes that have been blinded immediately take up their darkest phase and remain in it so long as they are kept in the light under normal conditions. Osborn (1941b) found enucleation of catfish a convenient way to keep them in the dark phase, and found that the deposition of pigment in this blinded form to be decidedly above that found in the normal condition. Odiorne

(1937) obtained the same results and emphasized that the pigment changes were due not only to dispersion of the granules of the existing cells but to an increase in the number and melanin content of the cells. The number of melanophores was increased in the dermal layers and even more strikingly so in the epidermis. Mayerhofer (1909), working on *Esox lucius* Linnaeus, and Secerov (1909), working on *Nemachilus barbatulus* (Linnaeus), found that blinded fishes kept in the light assumed their dark phase permanently and that the ventral side developed pigment also. Murisier (1920-1921) found that blind trout, *Salmo lacustris* Linnaeus, became extremely dark when kept in the light. In the author's personal experience experimental blinding of both *Tilapia macrocephala* (Bleeker) and *Astyanax mexicanus* (Filippi) causes both these species to enter their darkest phase. Evidence to the contrary that has been found is that of Fukui's work in which he quotes Kumagai (1923) as claiming that the blinded young gray goldfish do not increase in pigmentation but lose pigmentation more easily than the eyed ones. Fukui himself reports that two out of twenty young blinded goldfish lost their melanophores while the remainder did not. Experimental blinding of young gray goldfish was repeated by Goodrich and Hansen (1931), 25 being blinded by enucleation and 25 by removal of lens and iris. In all these fish as well as in 25 controls the depigmentation process was carried on normally. It is difficult to see just why this contradiction should occur. Fukui did not give any description of his operative technique so it is possible that the exceptions were not completely optically insensitive to light, but the enucleated fish studied by Goodrich and Hansen were certainly totally blind. It has been impossible to evaluate Kumagai's paper since it was published in Japanese and is unavailable in this country.

On the other hand, fishes kept in the dark assume their lightest phase. Ogneff (1908 and 1911) found that pigmentation in goldfish of mixed color was finally reduced when they were kept in darkness. Murisier's work with trout agreed with this observation. Odiorne (1937) maintained a catfish, which had been previously blinded and had turned dark, in darkness and reported that after 23 days the excessive pigmentation had begun to disappear, the dorsal part of the body became dark green, the sides below the lateral lines became mottled a lighter green and the fins grayish.

Contrary evidence is presented for *Nemachilus barbatulus* by Secerov (1909) and Kudo (1922). Using a process of chemically extracting melanin from the tissues, Kudo claimed to find an increase in melanin in fishes kept both on a black background and in total darkness over the melanin content of controls. Secerov found that blinded animals kept in the dark showed the same coloration as those kept in the light although ventral pigmentation that appeared on the latter was absent from those kept in the dark.

The condition in cave fishes is pertinent in this connection for they are always deficient in pigmentation. Blind fishes, *Anoptichthys jordani,* from Mexican caves, show little pigment when compared with their surface ancestor, *Astyanax mexicanus,* and what little pigment is present seems to be correlated to a considerable extent with the degeneration of the eye. Thus the fish with completely degenerated eyes show far less pigment on the average than those with only partially degenerated eyes (Breder and Gresser, 1941a). The cave characins are not necessarily without melanophores but those they have are contracted similar to those found in the goldfish that

had been kept in the dark for 16 months with intact eyes (see for example Breder and Rasquin, 1943, Pl. Ic). Enucleation of the blind capsule and severing of the optic nerve in 50 each of these fishes, *Anoptichthys jordani*, did not bring about any increase in pigmentation within a six-month period. This may be due to some complicating genetic factor for succeeding generations of this species reared in the light showed no increase in pigmentation.

TABLE I
PIGMENTATION OF FISHES IN LIGHT AND DARKNESS

O pertains to the light phase
X pertains to the dark phase

	Darkness	Light	
		Light background	Dark background
Eyed Fish	O	O	X
Blinded Fish	O	X	X
Cave Fish	O	O	O

Integration of the above information is graphically demonstrated by Table I. From this it can be readily seen that two influences are at work on the fish which bring about the reaction of the pigmentary system. Not only is vision important, but light must strike the body of the fish in order to develop and maintain melanophores. Sumner (1940) found that the eyed fishes responded to their background so that the number of melanophores tended to vary inversely as the logarithm of the albedo. Also he found that the number of melanophores was not significantly affected by the intensity of illumination. The rapid changes in pigmentation, shown by many fishes, not associated with background colors but with various other environmental influences and items of behavior, are regarded not pertinent to the present consideration. This report is concerned with the effects of light on fishes as operating directly on the pigmentary system and through the intermediation of the eyes. Hogben (1942) divided the pigmentary responses into three categories: a primary or dermal reaction which is independent of the eyes, a secondary response which has to do with the reactions to dark backgrounds, and a tertiary response which has to do with the reactions to light backgrounds. The last two are ocular responses; the primary or dermal response is seen in this connection in the reactions of blinded fish and eyed varieties kept in the dark. He considers it must be either ". . . (a) an unco-ordinated response due to direct reaction of a pigmentary effector organ to the incident stimulus, or (b) a co-ordinated response involving some receptor organ other than the eyes." He cites the fact that melanophores in isolated pieces of amphibian skin deprived of circulation and nervous control can be made to respond directly to light. However, Mills (1932a and 1932b) found that the melanophores of fish skin were partially controlled by sympathetic and parasympathetic nerves and also by neurohumors secreted by the melanophore nerve ending in situ. Thus it would be difficult to ascertain by similar experiments on fish skin whether the melanophores were reacting to light directly or whether sufficient secretion remained in the skin to effect the reaction.

In the development of pigmentation in fishes time is an extremely important factor which is often overlooked by investigators of the subject. Thus the two out of twenty young gray goldfish in Fukui's experiment, and

the 75 gray goldfish studied by Goodrich and Hansen that continued to lose their pigmentation after blinding, might have redeveloped their pigmentation had they been retained a sufficiently long time. Perhaps the momentum of the process of depigmentation, carried on for a time after blinding, would have run its course and then a new process of pigmentation would have been initiated. This time factor makes it difficult to compare results of various investigators. It undoubtedly differs in various species of fishes for it took a matter of many months for the pigment to develop in the blinded goldfish, yet it apparently takes a much shorter time for catfish to assume an excess of melanin (Osborn, 1941b). This is in part probably due to the presence of an already functioning system of melanophores in the catfish, while those of the yellow goldfish are all contracted at best and few in number.

The new data here reported show that even yellow goldfish when blinded can develop an all-over gray color if given sufficient time. It is suggested that long term studies, as opposed to the short ones usually undertaken, would be productive of proportionally more definite and consistent results.

Summary

1. The development of a gray color due to the reappearance of large numbers of melanophores in two blinded yellow goldfish is described. This took place within a year of the operation.

2. The presence of a few contracted melanophores in an eyed yellow goldfish kept for 16 months in total darkness is reported.

3. A discussion is presented integrating the above material with existing information concerning the appearance and growth of melanophores under influences of light and of vision.

4. The fact that the time required for pigmentary responses to occur differs with the species of the fish suggests that this may be a contributory factor to the apparent discrepancies in the literature on this subject.

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AMERICAN MUSEUM OF NATURAL HISTORY, NEW YORK CITY.

Male Secondary Sexual Characters of *Dinematichthys iluocoeteoides*

By C. L. Turner

MANY of the brotulid fishes are viviparous and in a critical review of the occurrence and character of the male copulatory organs in the Brosmophycinae, Hubbs (1938) comes to the conclusion that all members of the subfamily are live-bearing. Hubbs expresses the opinion that, when the details of the copulatory structures of the males of the various genera have been worked out, the specific characters of the copulatory apparatus will be valuable in the taxonomic separation of the different genera. If the characters of the copulatory apparatus are to be used for taxonomic purposes it would appear that comparative studies should be made which would involve detailed dissections of the entire region of the urogenital sinus and descriptions of the relations of all the structures of the region. Most of the descriptions of the copulatory apparatus of the brosmophycine fishes have been made without recourse to much dissection (Gill, 1863; McCulloch and Waite, 1918; Ogilby, 1897, 1898; Poey, 1858–1860; Waite, 1905).

It is the purpose of this paper to present the results of a detailed morphological study of the male urogenital system and accessory structures of one of the brosmophycine fishes (*Dinematichthys iluocoeteoides*) which may serve as a basis for comparative studies on other members of the subfamily.

Dr. Leonard P. Schultz of the U.S. National Museum furnished two mature male specimens of *Dinematichthys iluocoeteoides* for the study. The specimens were collected on June 27, 1939, at Siulagi Point Reef, Tau Island.

External Appearance of Male Urogenital Aperture and Associated Structures

The region posterior to the anus and anterior to the anal fin is swollen and forms a rounded protruding mass. The line of contact between the skin and the mucosa of the urogenital sinus is crenated and irregular (Plate I, 1). Externally visible there are masses of swollen tissue which partially fill the cavity of the urogenital sinus and conceal the bases of a median, ventrally directed spine-like penis and a pair of flattened horny claspers. The swollen tissue in the ventral part of the urogenital sinus forms a pair of pads which lie upon and partially conceal a median ridge of denser tissue. The structures described above appear in a specimen in which the structures have not been disturbed. Other deeper structures appear when the walls of the sinus have been cut away and the claspers have been reflected.

Clasper Chamber and Contained Structures

All of the structures concerned in copulation are specialized parts of the genital sinus. A comparison of the sinus with that of a fish not possessing a copulatory apparatus indicates that in general the sinus of *D. iluocoeteoides* has become enlarged, the walls have given rise to a series of folds and membranes, some of which have become partially cornified, the lips of the vent have become permanently enlarged and swollen, and the genital papilla has become elongated, ventrally curved and cornified in its terminal part. Dense connective tissue pads, grooves and ridges have been developed where the

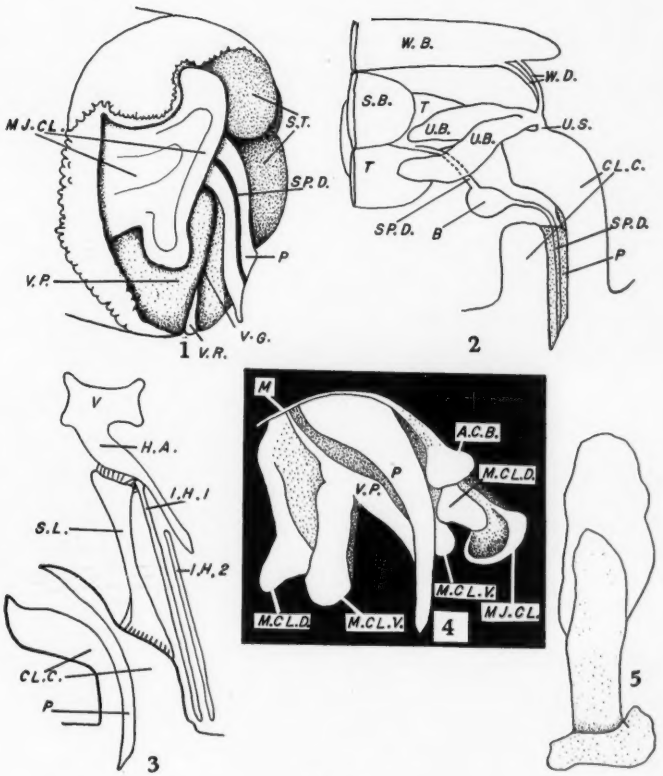

PLATE I

Abbreviations for all figures:

A.C.B., accessory cornified body; B., bulb of the penis; CL.C., clasper chamber; H.A., hemal arch; I.H.1, first interhemal ray of anal fin; I.H.2, second interhemal ray of anal fin; M, membrane connecting major claspers; MJ.CL., major claspers; M. CL.D., dorsal minor claspers; M.CL.V., ventral minor claspers; P., penis; S.B., swim bladder; S.L., suspensory ligament; SP.D., sperm duct; S.T., swollen soft tissue; T., testis; U.B., urinary bladder; U.S., urinary sinus; V., vertebra; V.G., ventral groove; V.P., ventral pad; V.R., ventral ridge; W.B., Wolffian body; W.D., Wolffian duct.

1 Structure of genital sinus viewed externally from left side.
2 Diagram of relation of structures of urogenital sinus to urogenital system.
3 Relation of skeletal structures to clasper chamber.
4 Structures of clasper chamber with left major clasper removed.
5 Left major clasper, dissected out, viewed from external face.

cornified parts have come into contact with the softer parts. The urinary sinus is unspecialized and forms no part of the complex. The term clasper chamber is used for the expanded and specialized genital sinus of the male. The anterior wall of the clasper chamber slopes downward and backward to form the floor of the chamber. All specialized structures concerned with copulation except the penis are attached directly to the anterior wall and the floor of the clasper chamber.

The penis is composed of dorsal, middle and terminal portions (Plate I, 2 and 4). The dorsal portion lies in the mid-line in the dorsal part of the clasper chamber, and is imbedded in the anterior wall. The dorsal part consists of a bulbous mass of connective tissue which is traversed by the sperm duct. Anteriorly and deeper within the anterior wall of the clasper chamber the sperm duct is greatly expanded to form a storage vesicle for sperm (Plate I, 2, B). The middle portion of the penis extends in a horizontal position, is somewhat flattened dorso-ventrally and is roughly of the same width as the anterior portion. The terminal part curves downward sharply so that the spine-like tip lies in a vertical position. It diminishes in diameter and near the tip the posterior surface is bevelled off. The opening of the sperm duct occurs upon this bevelled surface and is therefore subterminal in position. The duct of the terminal portion is surrounded by two lateral horny bodies which are fused in the mid-dorsal and mid-ventral lines except at their anterior ends (Plate I, 2, stippled structures). The anterior ends of the horny bodies are divergent and are imbedded in the connective tissue of the middle portion of the penis. The entire structure of the penis with its swollen basal part containing a bulb, its tapering and curving middle portion containing a central canal, and its bevelled terminal portion with the subterminal opening of the central canal upon the bevelled surface, produces a resemblance to a poison fang of a rattlesnake.

The penis is flanked by two pairs of claspers, and on the right side by an accessory cornified body which displaces the penis slightly to the left (Plate I, 4).

The outer or major claspers lie just within the outer walls of the clasper chamber on the right and left sides. The anterior end and the anterior portion of the ventral margins are imbedded in the tissue of the anterior wall and floor of the clasper chamber. A free membrane of connective tissue, attached to the dorsal margins of the anterior parts of the claspers, extends over the dorsal side of the penis. Attached to this membrane on the right side is the accessory cornified body (Plate I, 4). In Figure 4 the left major clasper has been dissected away but the accessory cornified body (A.C.B.) and the right major clasper (M.CL.D.) are shown attached to the membrane (M.). Each major clasper is roughly blade-shaped with the terminal part thicker, broader and flared outward (Plate I, 1 and 5). The long axis is horizontal. The anterior imbedded end (Plate 1, 5) is composed of a mass of dense elastic connective tissue surrounded by a tough sheath of white connective tissue. The middle and posterior portions, stippled in Plate I, 5, are strongly cornified. The internal face of the expanded terminal portion contains a shallow pocket within which rests the horny head of the dorsal minor clasper (M.CL.V. in Plate I, 4).

The accessory cornified body (Plate I, 4, A.C.B.) is a rounded, horny mass attached to the membrane joining the major claspers by a thin liga-

ment. It occurs only on the right side and is the only asymmetrical element in the copulatory complex. The cornified body is about as large as the expanded and rounded ends of the minor claspers.

There are two pairs of minor claspers (Plate I, 4, M.CL.D., M.CL.V.). The members of the dorsal or outer pair are roughly boot-shaped structures composed entirely of connective tissue. They are attached to the anterior wall of the clasper chamber by thick connective tissue membranes. Their outer and posterior margins are free. The ventral claspers (Plate I, 4, M.CL.V.) are also attached to the anterior wall of the genital sinus and to the dorsal claspers by thick connective tissue membranes. The posterior free ends are rounded and, unlike those of the dorsal minor claspers, they are cornified. In the normal undisturbed position the cornified heads of the ventral minor claspers are partially nested within the shallow depressions on the internal surfaces of the terminal, cornified parts of the major claspers.

The posterior part of the floor of the genital sinus is a thickened pad of soft tissue with a median groove in which the posterior part of the penis rests (Plate I, 1, V.P.). In the bottom of the groove, particularly in the posterior part, the tissue with which the penis comes into contact is raised to form a ridge of tough connective tissue (Plate I, 1, V.R.).

Internal Relations of Urogenital Organs to Clasper Chamber

The relations of the internal organs of the urogenital system to the clasper chamber are shown diagrammatically in Figure 2.

Minor sperm ducts from the testis join in the posterior part of the body cavity to form a common sperm duct (SP.D.). The duct extends ventrally and posteriorly between the anterior free ends of the urinary bladder and makes its way out of the body cavity and into the dense tissue forming the posterior wall of the body cavity. Here it expands into a vesicle (B.) which empties through a continuation of the sperm duct into the duct traversing the penis.

Paired Wolffian ducts (W.D.) emerge from the Wolffian bodies near the posterior ends of the bodies and join in the mid-line after a short excursion ventrally to form the urinary sinus. The urinary bladder, which is an anterior evagination of the urinary sinus, is bilobed for almost its entire length. The urinary sinus opens directly into the dorsal part of the clasper chamber without a urinary papilla. The simple relations which exist in the urinary system indicate that the system is not affected by the development of the series of complicated structures occurring in the adjacent genital sinus.

Relations to Skeletal Structures

Two distinctive features occur in the skeletal supports associated with the complicated genital sinus and copulatory apparatus (Plate I, 3). A thick strap-like suspensory ligament (S.L.) is attached at its dorsal end to the ventral surface of a single hemal arch (H.A.) and is imbedded at its ventral end in the tissues of the dorsal wall of the clasper chamber (CL.C.). The ligament is widened at its upper and lower ends for attachment. The first interhemal ray of the anal fin (I.H.1) is elongated dorsally to form a part of the support of the dorsal end of the ligament. The structural position of these two elements suggests that they are used in retraction of the genital sinus after copulation.

Summary

The structures and relations in *D. iluocoeteoides* which could be used for comparison with similar structures in other brosmophycine fishes and might be used to advantage in taxonomic separation of the different genera and species are as follows:

1. The genital sinus of the male is swollen, rounded and partially filled with soft connective tissue masses and externally visible, horny projections.

2. Displacement of the structures without dissection brings into view the following structures and relations:

a. A pair of blade-like major claspers lies just within the lateral wall of the clasper chamber. The dorsal margins are connected for a part of their length by a continuous membrane. The posterior cornified ends are flattened laterally, thick and flare outward.

b. A rounded, free, cornified accessory body is attached on the right side to the membrane which connects the dorsal margins of the major claspers.

c. Two pairs of minor claspers are attached to the anterior and ventral walls of the clasper chamber and to each other. The dorsal minor claspers are not cornified at the rounded free posterior ends while the members of the ventral pair are strongly cornified at the ends.

d. The penis, located in a dorsal median position, except for a slight displacement to the left in its upper part by the accessory cornified body, is a spinous structure which is strongly curved ventrally in its posterior third and is heavily cornified. The tip is bevelled on its posterior face. The middle and anterior parts of the penis are expanded, dorso-ventrally flattened and are composed of connective tissue.

3. Dissection of the region of the urogenital sinus reveals several additional structures and relations.

a. The sperm duct which traverses the penis is expanded into a large vesicle in the anterior wall of the genital sinus.

b. A heavy flattened suspensory ligament is attached at its ventral end to the dorsal wall of the genital sinus and at its dorsal end to the ventral surface of a posteriorly curved hemal arch.

c. The first interhemal ray of the anal fin is elongated at its dorsal end and forms a partial support for the dorsal ligament.

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Notes on the Effect of Cauterization in Fin-clipped Trout

By ELMER F. HERMAN

VARIOUS methods have been employed in marking fish. Among those tested are internal tags, paper clips on gill covers, pins with celluloid discs, Thorotrast—a chemical rendering the spleen, liver and kidney visible to X-rays, tags and fin-clipping.

Since time and output are controlling factors in any method used, fin-clipping is most commonly employed. It is pretty well established that amputating either of the pectoral fins close enough so that some flesh is excised makes the incidence of regeneration negligible. The same may hold true of the pelvic fins. Clipping the dorsal fin makes a marked fish strikingly visible to anyone. The incidence of regeneration, however, seems always high.

In an attempt to eliminate all regeneration of the dorsal fin, an experiment was initiated on October 6, 1943, and terminated on October 16, 1944. It was determined to clip the dorsal fin in the usual manner and then sear with a red hot resistance wire. The apparatus consisted of a Thordarson (T-19F89) transformer delivering 25 volts at 10 amperes through a nichrome resistance wire.

Three tanks of 55 mixed brown and rainbow trout, averaging seven inches in length, were used. The first tank was used for the controls, the second contained fish which were clipped, and the third held others which were clipped and cauterized.

The trout marked were anesthetized with ether. By the end of the third month, no fish had succumbed from the operation. Healing of the wound was in most cases complete. At the end of the sixth month, regeneration was in marked progress. On October 16, 1944, a year after the inception of the experiment, 88 per cent of the clipped fish manifested regeneration from small excrescences to almost complete replacement of the dorsal fin as shown in Plate I, 1.

On the same date, 98 per cent of the clipped and cauterized trout showed no regeneration whatsoever. Chromatophores had formed on the original location of the fin in almost all of these fish (Plate I, 2).

Cauterizing apparently eliminates all possibilities of regeneration of the dorsal fin with no more physical injury than simple clipping.

The method worked equally well on mature four and five year old brook and rainbow trout, using a small soldering iron for cauterizing. The time of healing in the older fish was more prolonged. Since an open wound is always an invitation to an infection, it would be advisable to use the cauterizing method on smaller fish wherever possible.

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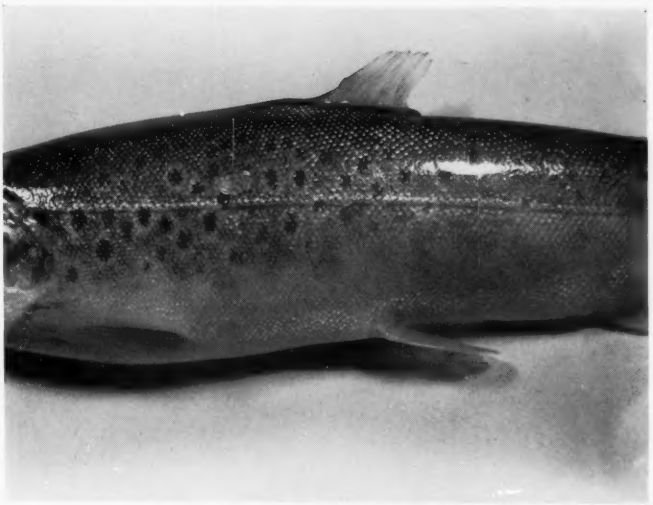

Fig. 1. Extent of growth of dorsal fin following clipping after an interval of a year.

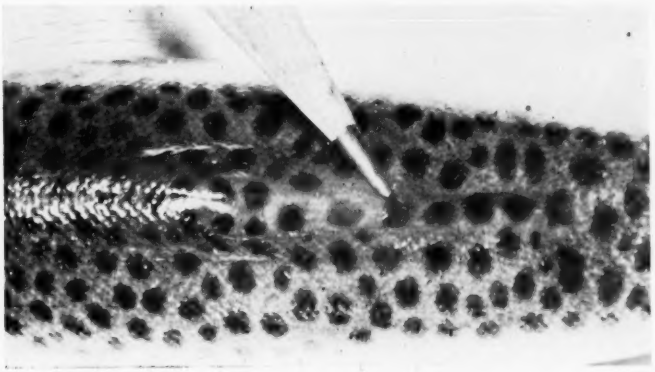

Fig. 2. Original location of fin replaced by new skin and chromatophores following cauterization.

PLATE I

Ichthyological Notes

PERTINENCE OF THE EAST INDIAN HETEROSOMATE FISH GENUS *LEPIDOBLEPHARON* TO THE CITHARIDAE.[1]—In a paper that has just been published, namely "Phylogenetic Position of the Citharidae, a Family of Flatfishes" (Hubbs, Misc. Publ. Mus. Zool., Univ. Mich., 63, 1945: 138, fig. 1), five genera of flatfishes were associated in a new and primitive family, the Citharidae. The pertinence to the Citharidae of *Lepidoblepharon,* one of the five genera, was regarded as highly probable though in need of confirmation. When the paper was written it was not possible to make the required check, because the only known specimen of *Lepidoblepharon,* the type of *L. ophthalmolepis* Weber, was deposited in the Amsterdam Museum, then beyond reach due to the war. As soon as communications with colleagues in liberated Holland became possible, a query was sent to determine the critical but heretofore overlooked characters of *L. ophthalmolepis.* With obliging kindness and thoroughness Dr. L. F de Beaufort promptly made all the needed examinations and reported his findings, with confirmatory sketches. His letter unfortunately arrived just too late to allow the inclusion of the newly available evidence in the monograph on the family. Consequently this supplementary note has been prepared.

The new data fully confirm the reference of *Lepidoblepharon* to the Citharidae. Dr. de Beaufort indicates that it possesses the prime characters of the family.

The pelvic rays number I, 5, a notably primitive feature. The first ray is a rather stiff spine without articulation. The second and third rays are simple but articulated. The fourth and fifth rays are also articulated and, at least in the right fin, are moreover branched.

The branchiostegal membranes are free and the gill-opening is extended far forward. The left membrane overlaps the right. Only 6 branchiostegals are counted.

The anus is a longitudinal slit on the eyed side, well above the mid-ventral contour. The urinary papilla is situated near the upper posterior corner of the anus.

There are tiny, somewhat hooked teeth on the head of the vomer. In the key on page 15 of the paper cited the items on vomerine teeth (under *4a* and *4b*) should be deleted or modified.

In all these characters Dr. de Beaufort reports that *Lepidoblepharon* appears to agree with *Brachypleura.* The pertinence of *Lepidoblepharon* to the Brachypleurinae as well as to the Citharidae therefore seems to be confirmed.

The family Citharidae is also named and discussed (on pages 235, 248, 252–254, 258, 262–263) in a treatise by Hubbs and Hubbs on "Bilateral Asymmetry and Bilateral Variation in Fishes" (Pap. Mich. Acad. Sci., Arts and Letters, 30, 1944 (1945): 229–310, figs. 1–2, pl. 1). According to all indications that paper was to appear first and it is stated on page 5 of the Miscellaneous Publication that the family name was proposed as new in the Academy series. The Academy Papers had been printed, but due to war-born conditions they had not yet been distributed by November 23, 1945, the authentic publication date of the Miscellaneous Publication, which therefore includes the original proposal of the new family name Citharidae.—CARL L. HUBBS, *Scripps Institution of Oceanography, University of California, La Jolla, California.*

RECAPTURES OF TAGGED WALLEYES. *STIZOSTEDION V. VITREUM* (MITCHILL), IN HOUGHTON LAKE AND THE MUSKEGON RIVER, ROSCOMMON COUNTY, MICHIGAN.—In 1939, 1940 and 1942 extensive tagging experiments were carried on by the Michigan Institute for Fisheries Research at Houghton Lake and the Muskegon River as part of an investigation on the life history and habits of the northern pike (*Esox lucius* Linnaeus). The results of these investigations have already been assembled and are being presented elsewhere. Coincident with the northern pike experiments at Houghton Lake, a total of 100 walleyes were taken in weirs, tagged, and released in 1939 and 1940. It was believed at the time of tagging that recovery of an adequate number of these marked fish would add to the little that is known of the movements of the walleye in inland lakes. Houghton Lake is the largest inland lake in Michi-

1 Contributions from the Scripps Institution of Oceanography, New Series, No. 291.

gan, 9½ by 5½ miles in its greatest dimensions, and with a maximum depth of 20 feet. Tagging was carried on in both years, during the spawning migration, at two points: (1) along the shore and in the tributaries of the North Bay, and (2) at a two-way fish weir constructed in the Muskegon River one mile downstream from the river's origin in Houghton Lake. The weir was in operation in 1939 from April 7 until June 19, and in 1940 from March 31 until July 11. Tagging of walleyes in North Bay was conducted at the same time. Details of the construction and operation of this weir have been described by Carbine and Shetter (Trans. Amer. Fish. Soc. [in press]). All walleyes were jaw-tagged according to the procedure described by Shetter (1936, Pap. Mich. Acad. Sci., Arts and Letters, 21 [1935]: 651–653). Details on the recapture of tagged walleyes are incorporated in Table II. The percentage of total recoveries of each tagging operation may be considered good in view of the large size of Houghton Lake (20,040 acres) and the relatively small number of walleyes tagged.

TABLE I

NUMBER OF WALLEYES TAGGED, WITH TOTALS AND PERCENTAGES RECOVERED BY PLACE AND DATE OF TAGGING

PLACE OF TAGGING	YEAR OF TAGGING	NUMBER TAGGED	TOTAL RECOVERIES OVER ENTIRE PERIOD 1939-1942	PERCENTAGE RECOVERED
Muskegon River Weir	1939	16	5	31.2
	1940	24	4	16.6
North Bay of Houghton Lake	1939	21	3	14.3
	1940	39	7	17.9
		100	19	19.0

These relatively high percentages of recovery reflect the intensity of the walleye fishery in Houghton Lake. The results of this tagging experiment and personal observations seem to indicate a high rate of exploitation and an early cropping of the walleyes soon after reaching the legal length of 14 inches. The 100 walleyes that were caught, tagged and released had an average total length of 373 mm. (14.7 inches) at the time of tagging. Exactly 60 per cent of the walleyes taken for tagging were caught by angling and indicate to some degree the size composition of the anglers' catch. Certain elements of human nature may also have contributed to the volume of recoveries. All of our recoveries were made by anglers and data were submitted to the Conservation Department purely on a voluntary basis since no intensive creel census has ever been in operation on Houghton Lake. Furthermore, at the time of tagging the majority of walleyes were just over legal length. Those that were not would, almost without exception, have attained legal length in the same season they were tagged. It seems logical to assume that the angler is more inclined to report data on the large fish in his creel than the undersized one he threw back. It is interesting to note that the walleyes entering the Muskegon River to spawn were larger and probably older than those entering the small tributaries around the North Bay of Houghton Lake. The same phenomenon was noted for northern pike. The average total lengths of the walleyes taken in the Muskegon River weir in 1939 and 1940 were 453 mm. (17.8 inches) and 448 mm. (17.6 inches) respectively. Walleyes caught and tagged along the shore and in the tributaries of North Bay averaged 308 mm. (12.1 inches) in 1939 and 332 mm. (13.1 inches) in 1940. These data suggest that the larger fish are seeking deeper and more extensive spawning grounds when the smaller tributaries around the lake shore are no longer adequate for these purposes. This is the only apparent explanation for the distinction in size between the samples examined.

Tagged walleyes were recovered as early as 15 days and as late as 796 days after tagging. Of 19 recoveries, 6 were made in the year of tagging (average 50 days), 9 were made one year after tagging (average 413 days), and 4 were made two years after tagging (average 782 days). There is no apparent reason for the recaptures being greater in number a year after tagging than in the same season of tagging. Recaptures were too few in number to indicate any pattern of movement for walleyes in Houghton Lake. That they are far-ranging in habit is evident. Recoveries were scattered throughout the length and breadth of the lake irrespective of the point of tagging. Distances traveled in the lake varied from 0.5 to 7.5 miles. Extreme cases of wandering were recorded. One

TABLE II

TABLE II

SUMMARY OF RECOVERIES OF TAGGED WALLEYES IN HOUGHTON LAKE AND THE MUSKEGON RIVER

	Tag number	Days out	Where recovered	Distance traveled (miles)	Total length at tagging (inches)	Total length at capture (inches)	Growth increment (inches)
1939 Tagging—Muskegon River Weir							
Number tagged—16							
1939 Recoveries:	4212	60	Middle Grounds	7.25	19.5	20.0	0.5
1940 Recoveries:	4215	497	North Bay	3.0	16.2	....	...
	4206	401	North Bay	3.0	18.9	....	...
	4209	359	South of Big Rapids Dam*	130.5	19.6	20.0	0.4
1941 Recoveries:	4201	780	Off Houghton L. village	7.5	17.5	18.5	1.0
1940 Tagging—Muskegon River Weir							
Number tagged—24							
1941 Recoveries:	12114	442	Houghton Lake	...	17.8	20.5	2.7
	12109	360	Below Big Rapids Dam*	131.0	18.8	19.0	0.2
	12105	452	Above Big Rapids Dam*	130.0	20.9	....	...
1942 Recoveries:	12111	791	Muskegon River	4.0	20.9	21.5	0.4
1939 Tagging—North Bay of Houghton Lake							
Number tagged—21							
1939 Recoveries:	4213	24	Middle Grounds	5.0	13.6	14.8	1.2
1941 Recoveries:	4225	762	North Bay	1.0	13.8	14.4	0.6
	4127	796	Houghton Lake	...	12.9	13.5	0.6
1940 Tagging—North Bay of Houghton Lake							
Number tagged—39							
1940 Recoveries:	12342	15	North Bay	1.0	11.3	....	...
	12338	18	North Bay	0.5	13.2	15.0	1.8
	12341	112	North Bay	1.0	13.0	13.0	0.0
	12593	69	North Bay	0.5	16.2	....	...
1941 Recoveries:	12350	382	North Bay	0.0	12.5	....	...
	12333	393	Houghton Lake	...	14.0	14.75	0.75
	12344	435	Off Houghton Heights	5.0	14.0	14.25	0.25

* Muskegon River.

walleye, tagged in 1939 at the Muskegon River weir, was recaptured in 1940 south of the Big Rapids Dam which is 130.5 miles downstream from the point of tagging. Two other walleyes, tagged at the same point in 1940, were recovered a year later just above and just below the Big Rapids Dam, having covered the same distance in a like period of time. Four, or approximately one-fifth, of the recoveries were made, one to two years after tagging, somewhere along the Muskegon River. Three of these fish had wandered approximately 130 miles downstream and it seems hardly feasible that they would return again to the lake. We may then have in these figures, an approximate measure of the walleyes being lost to Houghton Lake by migration into the Muskegon River to spawn. Growth data were recorded for only 13 recoveries and are far too inadequate to draw any conclusions. Data for individual specimens are included in Table I and are presented merely as a matter of record.—W. F. CARBINE and VERNON C. APPLEGATE, *Institute for Fisheries Research, Michigan Department of Conservation, University of Michigan Museums Annex, Ann Arbor, Michigan.*

TWO NORTHERN LONGNOSE GARS, *LEPISOSTEUS OSSEUS OXYURUS* RAFINESQUE, CAUGHT IN THE ESTUARY OF THE ST. LAWRENCE, QUEBEC.—These two fish were caught near Ste-Anne de la Pocatière, Quebec, along the estuary of the St. Lawrence River, 75 miles below Quebec city. The first one was caught in June, 1926, and was 42½ inches in total length; the other one (24 inches long) was caught in October, 1945, in a trap set along the shore.

Smith (1907), and Hildebrand and Schroeder (1928) mentioned that the gar pike ventures occasionally into salt water. Agassiz (1850) stated that: "the limits in which he is found . . . extend from Lake Michigan . . . down to the St. Lawrence and its outlet into the sea, into which this fish never ventures far, though he does not altogether avoid brackish and salt water." No mention of locality was made, however, nor of the salinity of the water in which the gar pike is likely to be found.

In the part of the estuary where the two *Lepisosteus* were caught, salinity varies from 13 $^0/_{00}$ to 20 $^0/_{00}$, and at the bottom, may be as high as 25 $^0/_{00}$.

As far as I know, Ste-Anne is the easternmost locality of the estuary from which *Lepisosteus osseus* has been recorded, and may be considered as its eastern limit of distribution in the St. Lawrence River.—YVES JEAN, *School of Fisheries, Ste-Anne de la Pocatière, Quebec.*

COLOR CHANGE IN A SCULPIN.—During the summer of 1945, while engaged in a fisheries survey of Great Bear Lake, N.W.T., for the Fisheries Research Board of Canada, we collected numerous specimens of the sculpin, *Cottus cognatus* Richardson. Great Bear Lake is the type locality of this species. Most of the specimens we saw were almost jet black but a few were quite pale and we believed, at first, that two species were present. One day as we were eating lunch near the water's edge we saw some fine black specimens and hastily deserted our meal to collect them. At the time the only vessel available in which to put them was a cream-colored enamel cooking pot. A few were secured and put in this pot and the hunt for more renewed. We were surprised to find a few minutes later that our black sculpins in the pot were now almost white. The black pattern was only faintly discernible as a series of pale, irregular markings. Later we timed this color change and found that it took place in from two to three and a half minutes.—R. B. MILLER, *Department of Zoology, University of Alberta, Edmonton, Alberta,* and W. A. KENNEDY, *Central Fisheries Research Station, Winnipeg, Manitoba.*

NEW SOUTHERN RECORD FOR ATLANTIC HALIBUT.—An Atlantic halibut, *Hippoglossus hippoglossus,* was taken in a pound net at or near Reedville, Virginia, by Mr. Ellis Williams on or about March 13, 1946. The boatman who brought the specimen to Washington reported that the fisherman had had an "awful time" with it, as it "attacked the men." The specimen was identified by Dr. Samuel F. Hildebrand, who furnished the following measurements: "Total length, 6 feet; length to base of caudal, 63 inches; head, 412 mm.; depth, 675 mm.; eye, 95 mm.; snout, 105 mm.; maxillary, 169 mm.; interorbital, 74 mm.; caudal peduncle, 108 mm.; shape of caudal, broadly concave; dorsal, injured sometime during life, healed, but several rays missing; anal, 71 rays; gill rakers, 7 on lower limb of first arch; color, plain brownish on right side." Bigelow and

Welsh, in 'Fishes of the Gulf of Maine' (Bull. U.S. Bur. Fisheries, 40, 1924, part 1: 474) say, "They are, or once were, caught in abundance off the eastern coast of North America from the Gulf of St. Lawrence and the Newfoundland Banks to the region of Nantucket Shoals, and occasionally as far south as New York."—L. A. WALFORD, *United States Fish and Wildlife Service, Washington, D.C.*

Herpetological Notes

EGGS OF THE LIZARD *GEHYRA OCEANICA*.—Four eggs of this form were collected in the northern Marianas. Two were found together under debris adjacent to a trail through dense jungle on Alamagan, May 14, 1945. Another two eggs were found under the bark of a decaying stump on Agrihan, May 16, 1945. The eggs were 14.0–14.2 mm. in length and 12.3 mm.–13.0 mm. in diameter. The shell was as firm as that of an ordinary hen egg. Natives of Alamagan stated that such eggs were frequently found along the trail.

When one of the eggs from Alamagan was broken on June 21 a fully developed lizard squirmed from the shell. A yolk ball 8 mm. in diameter was retracted within a few minutes. The color was brownish-black with light tan lines about 1 mm. wide crossing the back; the ventral surface light. The sides were flecked with gold; the eyes bronzed with dark flecks. The body length was 36 mm.

An egg of the Agrihan brood hatched July 5, 1945. The juvenile, similar to the one described, was sent to the Chicago Natural History Museum where it was identified as *Gehyra oceanica*.—FRED R. CAGLE, *Department of Zoology, Tulane University, New Orleans, Louisiana.*

TYPHLOPS BRAMINUS IN THE MARIANAS ISLANDS.—Information on *Typhlops braminus* was collected while the author was stationed with the Air Forces in the Marianas. Natives of Guam, Tinian and Saipan reported that these snakes were frequently seen on all three islands. Troops moving sandbags on Saipan reported seeing many of them.

A single specimen was collected on Saipan in June, 1945. Intensive collecting on Tinian from March to July, 1945, yielded only 5 specimens, and of these only two were retained. Two adult females were collected on Agrihan, May 16, 1945. A small juvenile was taken at Anatahan, May 9, 1945.

The two Agrihan specimens were taken from the center of a well decayed stump. The Anatahan specimen was under a large log partially buried in jungle debris. The snakes collected on Tinian were all found under railroad ties of a partially destroyed Japanese narrow gauge railroad bordered by fields of sugar cane. During the period March 18 to June 26 the ties and debris in this area were overturned at least 50 times in a study of the lizard population. Blind snakes were observed abroad only twice, both immediately after a heavy rainfall. Two were taken under one timber and three under another, March 31, April 19.

One of the two collected April 19 was a gravid female. Retained in a cigar box with moist dirt it deposited 3 eggs on April 21. The white elongated eggs (12 mm. x 3 mm.; 13 mm. x 4 mm.; 14 mm. x 3 mm.) had thin, semi-transparent, flexible shells with the yolk visible. They were placed in moist soil within a glass jar and were checked daily. Two of the eggs hatched May 29. The third egg, when opened, contained a completely developed dead snake. The two hatchlings measured 62 mm. and 53 mm. respectively in total length.—FRED R. CAGLE, *Department of Zoology, Tulane University, New Orleans, Louisiana.*

BURROWING OF *PLETHODON JORDANI*.—The red-cheeked *Plethodon jordani* was observed in burrows along the cut banks of the Appalachian Trail just northeast of Newfound Gap in the Great Smoky Mountains, shortly after dusk on the evening of May 22, 1945. I was accompanied by Dr. and Mrs. A. S. Margolin, and our observations were made mostly on the Tennessee side of the state boundary, which is closely paralleled by the trail. The weather was clear and cool, temperature about 55° F., and relative humidity low, although there had been a light shower in the afternoon. Except in dense woods the trail and the vegetation along its sides were slightly damp.

Immediately after leaving the Gap, we began to find scattered individuals of *Plethodon jordani* on the sandy cut banks above the trail, and began to see them with their heads or portions of their bodies protruding from burrows in the sandy loam banks of the trail. Some of the emerging animals had reddish sand still adhering to their bodies. Those that had completely emerged were inclined to be sluggish in the cool air, but those with just their heads out of the burrows were anything but sluggish, and frequently darted back into the burrows at our too close approach.

The red cheek-patches could easily be seen under our head lamps, even when only a bit of the head appeared. As we climbed into denser woods the trail and its banks grew drier, and we did not find any *P. jordani* completely exposed, although their burrows were often abundant. Many of the burrows had very tiny openings, and some of them were surrounded by a rim of pushed-up fresh soil, indicating that the animals were making the openings from the inside. We saw a few of the openings made. The soil was pushed out until a very small opening appeared, and we could see the snout of the animal just breaking the surface. So far as we observed, the animals in these drier sites did not emerge completely.

A few of the burrows from which the animals emerged, or from which they stuck their snouts, were fairly large and prominent, perhaps three-fourths inch in diameter. Usually, however, the burrows did not exceed one-half inch in diameter near the openings. None was found with an opening as large as those reported for *P. metcalfi* (1940, Chadwick, COPEIA: 50). The location of the burrows on the side of the cut banks varied from an inch or so below the top of the bank's exposure to as much as two feet below.

Extensive excavation was not feasible, but with the cutting edge of a geologist's hammer I tried repeatedly to throw the animals to the surface by striking behind them without success. By probing we were able to determine that the burrows were at least 18 inches in length; they were probably much longer.

It was difficult to form any accurate idea of the numbers of salamanders, since many of them were at openings so tiny as to make observation difficult, and presumably others did not break the surface at all during the time of our observations. Seven openings in the space of one square foot were counted, and this density did not seem exceptional.

Where the banks were damper, or where they were covered with moist vegetation, numbers of the animals were outside their burrows, but we did not find any far from the openings. Most individuals showed alarm when the head lamp was turned on them, and tied to escape by retreating into the burrows.

All of the Jordan's salamanders seen in or about the openings were adults, so far as we could determine, while sub-adults were abundant under logs and stones in the same region. I later returned to the area with Arthur Stupka, park naturalist, who collected a series of the animals. These proved to be about equally divided as to sex.

Burrowing seems to be a well known habit of some other closely related plethodons. —MAURICE BROOKS, *West Virginia University, Morgantown, West Virginia.*

AN ALBINO PILOT BLACK SNAKE FROM NORTH CAROLINA.—An albino specimen of the pilot black snake, *Elaphe obsoleta obsoleta* Say, was reported to the North Carolina State Museum by Mr. E. Wade Crawford, and was subsequently obtained from the owner, Mr. D. E. Holbrooks, of Stanfield, Stanley County, North Carolina. Mr. Holbrooks states that the specimen was pure white in life, with bright red eyes. The specimen measures 1153 mm. over all, with a tail length of 175 mm. Dr. C. S. Brimley says that he has not before seen a completely albinistic snake in North Carolina.—FRANK B. MEACHAM, *Curator of Zoology, North Carolina State Museum, Raleigh, North Carolina.*

HYLA CRUCIFER IN TEXAS.—The spring peeper, *Hyla crucifer crucifer*, has not previously been reported from Texas, although its recorded range, covering Kansas, Arkansas and Louisiana (1942, Wright and Wright, Handbook of Frogs and Toads: 140), makes it appear likely that it would be found in the humid eastern portion of the state.

On March 2, 1946, while collecting beside the Normangee Lake spillway in Leon County, Texas, a single specimen of this *Hyla* was taken from the stubble of the previous year's cattail growth. This individual (in the Texas Cooperative Wildlife Collection) is an adult female, length 28 mm., with the bar between the eyes and the dorsal cross plainly marked. The immaculate condition of the venter and the dimensions of the pectoral and inguinal areolae leave no doubt that the Texas form is typical *H. c. crucifer* rather than *bartramiana* of the southeastern coastal plain. The presence of the species in this locality extends the range approximately 160 miles westward from the Louisiana border, and aids in defining the large area of east Texas where this form may be expected to occur.—BRYAN P. GLASS, *Department of Fish and Game, Agricultural and Mechanical College of Texas, College Station, Texas.*

AN AGGREGATION OF PACIFIC SEA TURTLES.—While I was enroute by ship from San Diego, California, to the Panama Canal Zone an unusually large number of marine turtles was encountered throughout the day on November 28, 1945. The species was subsequently identified as *Lepidochelys olivacea* (Eschscholtz). On this date our location was approximately 50 miles off the coast of the Mexican State of Guerrero. Our course was southeasterly at a speed of 15 knots. The sea was exceedingly calm with virtually no wind or swells. The turtles were first called to my attention at 9:30 A.M., but I was not able to observe them personally until after 11 A.M. At this time 24 individuals were within sight. The turtles were floating idly on the surface with the upper one-third of the carapace, and rarely the head, protruding above the surface. Individuals were usually at least 500 yards from the nearest neighbor so that there was no close aggregation. All seemed to be adult or subadult, ranging in estimated carapace length from 18 to 30 inches. A large bird, probably the masked booby, was utilizing the turtles as a place of rest; birds were standing on approximately half of the turtles. The number within sight at any one time remained fairly constant until about 3 P.M., when progressively fewer were seen. Several schools of porpoises and about 15 sea-snakes, *Pelamis platurus*, were observed during the same period of time.

At 1 P.M., a small motor launch was put in the water in an endeavor to collect some of the turtles. The method used was to approach to within 10 or 15 yards of the turtle, to shoot it in the anterior part of the carapace with a forty-five calibre gun, and then have a swimmer grab the turtle by the carapace to bring it to the boat. The turtles were easily approached, making little or no effort to escape until the boat was nearly upon them. When we approached one turtle that had a bird on its back, the bird flew away when the boat was within 15 yards range. The turtle seemed completely oblivious of the bird's departure, but when the boat closed to six yards, the turtle raised its head from the water, sighted the boat and hurriedly started to swim away. The shooting served to stun the turtle so that the swimmer could reach it before it escaped. Once the swimmer had secured the turtle by the carapace and turned it upside down, it was easy to handle. Even a large turtle seemed relatively helpless in the water when on its back. The turtles made little effort to bite, although in their efforts to escape, the claw on the front flipper inflicts a dangerous wound. One made a two-inch long cut in the wrist of the swimmer, while another tore an inch-thick piece of wood out of the gunwale of the motorboat.

Three turtles were caught in a little over one hour's time and a fourth escaped after being grabbed by the swimmer. The smallest specimen was a male with a carapace length of 24 inches. The other two were females, the larger having a carapace length of 28 inches and an estimated weight of 80 pounds. At the time the turtles were caught the ship's position was 15° 57′ North latitude, 99° 46′ West longitude. The depth of water, obtained from the U. S. Hydrographic chart, was 2738 fathoms. The air temperature was 88° F.; water temperature 86° F. There was no obvious correlation of any activity with the large number of turtles sighted during this six-hour period. I have seen marine turtles of several species on various occasions during the last two years in both the Atlantic and Pacific, but never in such abundance.—JAMES A. OLIVER, *Department of Amphibians and Reptiles, The American Museum of Natural History, New York City.*

AN AUTOPHAGOUS LIZARD.—In a forested area near Nadzab, in the Markham Valley, British New Guinea, I frequently collected the gekkonid lizard, *Gehyra oceanica* (Lesson). On the night of May 7, 1944, I caught a particularly fine female of this species. Intending to photograph the specimen, I did not preserve it immediately, but left it overnight in a heavy canvas bag. The following day the lizard's tail was found to be missing, while the abbreviated reptile was suspiciously stouter. Pressure on the lizard's sides forced it to disgorge the missing member, already faded by digestive fluids. The organ had been swallowed in its entirety, tip first, sometime during the night. In this species the tail is long, depressed, and rather broad at the base, with serrated lateral edges; and in consequence, the reptile's capacity had been strained to the utmost. Investigation of the habits of *G. oceanica* threw some light on such apparently eccentric behavior. The species was found to frequent deep forests, where crepuscular conditions prevailed even throughout the day. Specimens were rarely seen abroad either by night or by day. Individuals could always be found, however, beneath loosened slabs of bark on large trees. Captive examples were positively thigmotactic, wedging themselves into any available crevice. Two stomachs that were examined contained coleopterous larvae and the remains of smaller gekkonids and such prey is probably captured beneath the bark. When grasped, the geckoes writhed with considerable agiilty, and unless seized by the anterior part of the body they would practice autotomy, the tail parting from the body at a point just posterior to the vent. In such cases the severed organ thrashed about for a minute or more. These facts suggest a reasonable explanation of the occurrence of "autophagy." For some reason, the characteristic autotomy took place in the bag. and coming in contact with its own but separated tail, the lizard swallowed the writhing object just as it might a small gecko or other prey.—WILFRED T. NEILL, *Augusta, Georgia.*

A CONGRESS OF FOWLER'S TOAD.—A mixed woodland, three miles north of College Park, adjacent to the Beltsville Station of the U. S. Bureau of Plant Industry, has been untouched for the past forty years. The general area is low, boggy in many places, and approximately 500 yards from a small stream (Little Paint Branch). The soil is in general sandy to gravelly in character, and the area floods readily in wet weather.

The common toad of this locality is *Bufo woodhousii fowleri* Hinckley, which may be said to be abundant, as individuals may be readily observed in groups of 2 or 3 under boards, adjacent to house foundations, and in gardens. Wright and Wright (1942, Handbook of Frogs and Toads: 99) note that in specimens of this species sent to them from Virginia, one was dull greenish, another was reddish. In this locality the larger specimens are either dull or bright green, but most of the smaller individuals are distinctly reddish brown, with a prominent mid-dorsal white line.

The latter part of July and early August of 1945 were very rainy, and during this time an unusual association of these toads was observed. Beginning on July 14, there was an almost continuous downpour until 6:00 P.M. of the 19th. By this time the yards in the small residence development in this area were covered by shallow pools ranging in depth from 2 to 12 inches. Beginning about 8:30 P.M., loud screeching wails were heard. These intermittent screams continued to increase in volume and extent until the noise became practically continuous at 10:30 P.M. The noise continued until midnight, when it again became intermittent and finally ended rather abruptly about 1:30 A.M.

The pools of water were literally filled with toads. It was impossible to count the actual numbers present but some indication may be given by the fact that 31 were collected in less than 5 minutes. They were about equally divided as to sex, there being 17 males and 14 females. The same behavior was observed the two following nights, when the rain again stopped for a few hours. On these two occasions the noise was not as great, nor were as many toads present. Despite a thorough search, no evidence of mating or egg-laying was found.

The toads when first collected, or observed on the lawn, were bright green in color. Upon being placed in terraria, the bright color faded to a dull green or yellow-green. One-half of the males observed had the characteristic yellow color of the femur and groin on the right side of the body only. None was observed to have such coloration on the left side alone. This color was not present on the females.—ROBERT A. LITTLEFORD, *Department of Zoology, University of Maryland, College Park, Maryland.*

SWIMMING ABILITY OF THE ALLIGATOR LIZARD.—In the light of the following observation, it appears desirable to investigate more carefully the frequent verbal reports concerning the swimming ability of the southern California alligator (*Gerrhonotus multicarinatus webbii* Baird) as well as its occasional foraging in shallow water. I had mentally rejected as improbable most reports of aquatic habits for the lizard, possibly because I have tested, with negative results, the statement that the animals sometimes feed on tadpoles found in shallow water.

While trout fishing in Big Rock Creek above Valyermo, Los Angeles County, California, June 20, 1940, I observed unusually large numbers of alligator lizards basking or moving about in tangles of flood debris adjacent to the stream channel. On one occasion one of these lizards either fell or jumped into the water from its support a foot above the fast-flowing mountain brook.

Under similar circumstances many lizards seem to be capable of swimming by use of the regular running gait, which gives them a "dog-paddle" type of swimming. It was therefore rather surprising to see this lizard adopt a serpentine movement and dive steeply against the swift, cold stream and seek refuge beneath a flat rock about 18 inches below the surface of the water.

We watched for the lizard's emergence for about two minutes and when it failed to appear, the covering rock was carefully lifted away, but the lizard had managed to crawl away under adjacent rocks.—Raymond B. Cowles, *Department of Zoology, University of California, Los Angeles, California.*

THE EGGS OF *PSEUDOTRITON MONTANUS MONTANUS*.—Although *Pseudotriton montanus montanus* (Baird) occurs from Carlisle, Pennsylvania, south to South Carolina and northeastern Georgia, information concerning its breeding habits has been based solely on observations made in North Carolina. Brimley (1939, Carolina Tips, 2, 5: 19) has recorded the eggs in November, December and January in the run-off of a small spring near Raleigh. The eggs were white and unpigmented and were attached to dead leaves and other detritus lying in the water. It could not be determined whether the eggs were laid in definite groups or were merely deposited close together. A few of the eggs measured by Dunn (1926, Salamanders of the Family Plethodontidae: 290) were 6 mm. in diameter and were provided with an attachment stalk 4 mm. long.

This article records observations on the eggs of this salamander in Maryland, especially as regards the rather unusual way in which some of them were attached. The material that forms the basis for this note was collected in a cypress swamp along Battle Creek, Calvert County, Maryland. While collecting along the floodplain of this creek on December 27, 1942, a trickle of water was noted seeping from a small opening at the base of the adjacent hillside. Upon probing into this opening a few salamander eggs were disclosed. Closer examination revealed that these eggs had apparently been dislodged by the probing since others could be seen still attached to rootlets growing down into the hole excavated by the water. Still other eggs back beyond reach seemed to be adhering to the wet walls of the chamber. About six eggs attached to a rootlet were removed. Each egg was stalked and these stalks were so intertwined that a small cluster of eggs was formed, all of which were attached to a more or less common point on the rootlet. Because of the disposition of the eggs it was impossible to determine accurately the total number of eggs present, although about 25 were collected. The various eggs noted were in different stages of development ranging from those containing well-developed embryos at the point of hatching to others showing no signs of development. It thus seems probable that there was more than one set of eggs present which had been laid at different times.

In addition to the eggs collected, two adults of *P. m. montanus* were obtained by digging into the mud at the bottom of a small seepage pool on the nearby floodplain. These adults were deeply buried in this mud and were discovered only by their movements as the mud was turned out on the bank. Return trips on January 17, 1943, and June 20, 1943, yielded three more adults and a series of larvae from this same pool.—J. A. Fowler, *The Sidwell Friends School, Washington, D. C.*

RECORDS OF CERTAIN NORTH AMERICAN SALAMANDERS.—A recent survey of the herpetological collections of the Eastern Illinois State Teachers College, together with records from my personal collection, have disclosed several slight extensions in the ranges of various species of North American salamanders, as stated and mapped in the recent work of Bishop (1943, Handbook of Salamanders). They are as follows:

Ambystoma opacum (Gravenhorst)—Collected April 19, 1941, by P. E. Smith at Rolla, Phelps County, Missouri. This record extends the known range some 40 miles to the west.

Plethodon cinereus cinereus (Green)—Collected March 29, 1941, by an EISTC field group, at Rocky Branch, Eastern Edgar County, Illinois, and by me at Lake Vermilion, Vermilion County, Illinois. These records furnish southward and westward extensions of the known range.

Plethodon glutinosus glutinosus (Green)—Collected by Walter Scruggs on September 22, 1940, at Mason, Effingham County, Illinois, and in October, 1940, at Shelbyville, Shelby County, Illinois. The records represent a northward extension of approximately 100 miles in Illinois.

Eurycea bislineata bislineata (Green)—Collected by Walter O. Scruggs at Rocky Branch, Edgar County, Illinois.

Eurycea longicauda melanopleura (Cope)—Collected April 21, 1941, by P. E. Smith in a cave near Waynesville, Pulaski County, Missouri. Three of the specimens have well developed cirri; the remainder are juveniles. These specimens are from the northern range limit of the species.

Eurycea lucifuga (Rafinesque)—Collected April 21, 1941, by P. E. Smith in a cave near Waynesville, Pulaski County, Missouri. This species has not been previously recorded from central Missouri.—JAMES A. PETERS, *Museum of Zoology, University of Michigan, Ann Arbor, Michigan.*

NOTES ON THE SECONDARY SEX CHARACTERS OF *THAMNOPHIS RUTHVENI*.—Noble (1937, Bull. Amer. Mus. Nat. Hist., 73: 673–725) thoroughly discusses the various sense organs involved in the courtship of *Thamnophis butleri* and *Thamnophis sirtalis sirtalis*. He describes in some detail the tubercles found on the mental, chinshields and anterior labials in the males of these species. Although mentioning innervations of the dorsal head scales, he makes no definite statement as to the presence of actual tubercles on these scales.

In an examination of the *radix* group of the genus *Thamnophis*, I have noted the presence of these tubercles on the chin scales in males of *Thamnophis butleri, radix,* and *macrostemma*. In some specimens of *radix,* small tubercles are infrequently found on the prefrontal and internasal scutes, although many and somewhat larger tubercles are found on the chin scales of the same specimens. The tubercles of males of *Thamnophis marcianus,* though still present on the chin scales, become more numerous on the prefrontals and internasals, and a very few specimens show tubercles on the anterior temporals. I have seen no tubercles on the dorsal head scales of females of either *radix* or *marcianus*.

In the typical series of *Thamnophis ruthveni* Hartweg and Oliver (U.M.M.Z. Nos. 82469–82510) from the vicinity of Tehuantepec, Oaxaca, Mexico, no tubercles are present on the chin scales. Sixteen males have the tubercles confined to the following dorsal head scales: rostral, frontal, anterior upper labials, prefrontals, internasals, nasals, loreals, oculars, and usually the anterior temporals. Five of the specimens have tubercles also on the distal border of the parietals. Four females have the dorsal head tubercles present: three have them confined to the prefrontals and internasals, while the fourth has almost as many and as great a distribution as in the males. Four of the twenty males lack the tubercles. These are juvenile and presumably sexually immature specimens. All adult males have knobbed keels on the lateral scales in the cloacal region.

Noble (*op. cit.*) suggests that the chin tubercles are used as an aid in recognition of the sexes in the courtship of *Thamnophis,* in which the male rubs the dorsum of the female with his chin. The presence of these tubercles on the dorsal head scales suggests a different courtship pattern in *Thamnophis ruthveni*. It is possible that the males of *ruthveni* rub the venter of the female, or, instead of passing the chin over the dorsum, the head may be rubbed along the sides.—ALBERT G. SMITH, *Museum of Zoology, University of Michigan, Ann Arbor, Michigan.*

THE SIZE OF THE SLIMY SALAMANDER.—On September 16, 1944, I collected an unusually large female *Plethodon glutinosus glutinosus* (Green) in Frick Park, Pittsburgh, Allegheny County, Pennsylvania. The total length of the freshly killed specimen (CM 23354) was 188 mm.; now, after sixteen months in preservative, the total length is 186 mm., the snout-to-vent length, 88. This appears to be the largest female *glutinosus* thus far reported, and raises the question of whether males of this species actually exceed the females in size as stated by Bishop (1943, Handbook of Salamanders: 251). Certainly, this specimen, and Dunn's earlier record (1926, Salamanders of the Family Plethodontidae: 139) of a 182-mm. female from Tennessee, demonstrate that the discrepancy in size of the two sexes is less than indicated by Bishop's size ranges (males, 121–188 mm.; females, 105–168 mm.).

Of 532 *glutinosus* from Pennsylvania in the Carnegie Museum, the four largest males vary from 142 to 170 mm. in total length, the four largest females from 160 to 186 mm. The three largest males of 407 West Virginia specimens range from 160 to 165 mm., the three largest females from 160 to 168 mm. Although I know of no female *glutinosus* that exceeds the maximum total length for males given by Bishop, examination of several Carnegie Museum series suggests that in a given population the females tend to average larger than the males.—GRACE L. ORTON, *Carnegie Museum, Pittsburgh, Pennsylvania.*

THE CORRECT NAMES OF SOME TOADS FROM EASTERN UNITED STATES.—Since the time of Holbrook (1836, N. Amer. Herp., ed. 1, 1: 76) it has been common knowledge among herpetologists that the toads customarily referred to as *Bufo americanus americanus* and *Bufo terrestris* have mutually exclusive ranges, the latter occupying the southeastern coastal plain and meeting the former—an upland form in the southern portion of its range—along the Fall Line. In recent years, several workers (Burt, 1935, Amer. Midl. Nat., 16: 314; Chamberlain, 1939, Charleston Mus. Leaflet, 12: 8; Harper, 1935, Amer. Midl. Nat., 16: 287) have reported intermediates from various localities along the physiographic boundary, without making the necessary nominal change. Dunn, without mentioning intergrades, listed *Bufo terrestris amercianus* [*sic*] and *B. t. terrestris* in a mimeographed list of the amphibians and reptiles of Virginia (1936: 2, Haverford). This list was not widely distributed, and Dunn's usage has not been followed. Subsequently, Burt (1938, Trans. Kans. Acad. Sci., 41: 336) considered them to be geographic races, but he inadvertently used *americanus* Holbrook, 1836, as the specific name, rather than *terrestris* Bonnaterre, 1789.

In our studies of southeastern amphibians we have encountered no difficulty in separating the lowland representative, *terrestris*, from the upland form, *americanus*. We have examined numerous specimens from Fall Line areas which are intermediate in their characters and which may be presumed to be intergrades. The extensive experimental work of Blair adds confirmation, for he states (1942, Biol. Symposia, 6: 236) that *terrestris* is the closest relative of *americanus*.

In view of the relationship indicated, the members of this polytypic species should be designated as follows:

Bufo terrestris terrestris (Bonnaterre), 1789

Coastal plain from extreme southeastern Virginia to the southern tip of Florida, and westward to Louisiana and Arkansas.

Bufo terrestris americanus Holbrook, 1836

Eastern North America from the Height of Land in Ontario and Quebec, southward to the southern edge of the Piedmont in Georgia and Alabama, and westward to the eastern boundary of the Great Plains.

Bufo terrestris copei Yarrow and Henshaw, 1878

Forested portions of James Bay drainage of Ontario and Quebec, east coast of Hudson Bay at least to Great Whale River, and Labrador.

—M. GRAHAM NETTING, *Carnegie Museum, Pittsburgh, Pennsylvania,* and COLEMAN J. GOIN, *University of Florida, Gainesville, Florida.*

HERPETOLOGICAL NOTES FROM TRINIDAD.—While in service as medical officer in the U. S. Navy, I had occasional opportunity for brief herpetological observation and collecting. I was at Trinidad, British West Indies, from August 24 to September 15, 1943, and again from March 24 to April 9, 1944. On my first visit the scarcity of animal life on the coastal plain area ten miles west of Port-of-Spain was most disappointing. On the occasion of my second stay I collected at Tucker Valley, where a wide swampy bottom, largely drained and occupied by citrus fruit plantations, with patches of jungle, is enclosed by steep hills on either side. The list of species collected follows.

LIZARDS

Thecadactylus rapicaudus Houttuyn.—A juvenile specimen was taken March 31, at night, and an adult escaped by running up into the foliage of a bamboo thicket. The motions are cat-like. In the jungle above Scotland Bay, on April 9, I found an adult under the bark of a dead stump, about eight feet above the ground. It ran out and was easily caught, appearing blinded by the daylight. The vertical pupil of its eye was scarcely visible, so tightly was the iris contracted in the sun. This fellow was rather ferocious and tried to bite. It also emitted a bat-like squeak when first caught. I was surprised at the delicacy of the soft skin which tore even with careful handling.

Gonatodes humeralis (Guichenot).—One specimen was secured as it dodged around to the under side of a log in upper Tucker Valley, April 6. This individual was noted to have a definite orange coloration on the ventral side of its tail. Another was found in a deserted native mud-brush hut, on the northern side of Scotland Bay, April 9.

Gonatodes vittatus (Lichtenstein).—Two specimens were secured in a rotten log on the southern hillside above Scotland Bay, April 9.

Anolis chrysolepis Duméril and Bibron.—One individual observed on the ground on March 24. One specimen caught sleeping on a leaf about seven feet above ground during a night expedition on March 31. It was rather inert but attempted to bite. This species was certainly not common in this locality.

Scolecosaurus trinitatis Barbour.—Two individuals were seen in the brushy jungle floor but they escaped. One small specimen was caught in a rotten log. They all attempted to escape by burrowing rapidly under and into the humus on the jungle floor. Their actions were very snake-like. The color in life was dull orange dorsally with light streaks on either side. The elongated tail had a somewhat purplish hue on its distal half.

SNAKES

Oxybelis acuminatus (Wied).—I saw only one specimen, at night. It was climbing on a palmetto frond about four feet above the ground, and was not difficult to catch. Its rather bright olive-brown dorsal coloration and light yellow ventral hue faded to a gray that revealed a dorsal mottling in alcohol.

Atractus trilineatus Wagler.—One small individual was found under a log in the old creek bed. Its color was dull gray; its lines were more definite than usually seen in adult specimens.

FROGS

Bufo marinus (Linnaeus).—Fairly common in drainage ditches. They are easily caught at night with a light. Juvenile specimens were secured; tadpoles, possibly of this species, were found in one drainage ditch.

Eupemphix pustulosus trinitatis Boulenger.—Three specimens were found at night on a recently cleared jungle hillside in upper Tucker Valley. In life this species is dull gray in color.

Leptodactylus petersi (Steindachner).—These frogs abounded along creek beds in several localities. They were particularly common where dried leaves covered stream beds to the depth of several inches. Here they hopped about with great agility, fairly swimming through the leaves.

Eleutherodactylus urichi (Boettger).—This species was found to be quite common in the same localities as *Leptodactylus petersi*, but was slower in action and not so numerous. I found several in the jungle and in grassy areas at night. During the day they were to be stirred from under stones. In life the iris is characteristically bright green; the thighs are more or less crimson.—MURRAY L. JOHNSON, *% Department of Zoology, College of Puget Sound, Tacoma, Washington.*

REVIEWS AND COMMENTS

AMPHIBIANS AND REPTILES OF THE CHICAGO AREA. By Clifford H. Pope. Chicago Natural History Museum, Chicago, Illinois, 1944: 1–275, pls. 1–12, text figs. 1–50. $1.75.—The appearance of a number of popular handbooks on reptiles and amphibians during the past few years is a healthy sign—an indication that herpetology is coming of age and is no longer the exclusive topic of a few score specialists. Latest newcomer to the parade of volumes for the layman is this fine compendium about the fifty-two species and subspecies that occur in and near America's second largest metropolitan area.

Each of the major groups—salamanders, frogs and toads, lizards, snakes, and turtles—has its own introduction followed by a simple identification key that may be easily employed by an intelligent reader. The detailed discussion of each individual kind of amphibian and reptile is liberally sprinkled with subtitles, and this is a boon indeed for anyone seeking a specific item of information. Under the marbled salamander, for example, there are the following subheadings: Recognition, The Sexes, Reproduction, Growth and Age, Habits, Food, Habitat, Captivity, Occurrence, and References. Writers of multi-paged monographs would earn the enduring plaudits of their colleagues if they borrowed Mr. Pope's style and sprinkled their tomes with a multiplicity of time-saving subheads.

Wherever possible, information is presented about the habits and characteristics of specimens actually from the Chicago region, but where such data are lacking (and they are missing a surprisingly large number of times) the author has drawn upon published material, wisely selecting, when available, that which is based upon populations from other states or regions close to the Windy City. The text reflects the painstaking search and sifting of the literature for which Mr. Pope is noteworthily famous. Also commendatory is the straightforward manner in which details of mating of various species are discussed, even though it is obvious that a large proportion of the book's audience will consist of juvenile readers. The illustrations, beginning with an amusing sketch of a salamander on the cover, are both useful and attractive. Many of the drawings and photographs are new, but others, borrowed from numerous sources, have been published previously. There are six pages in full color.

Oversimplification of some of the keys and paragraphs on identification have led to the omission of obviously easy means of distinguishing between species. Thus, there is no mention of the great difference in the relative sizes of the tails of the musk and snapping turtles. Nor, in the case of the confusingly similar (to the novice) milk and fox snakes is there any reference to the condition of the anal plate (single or divided, respectively) that furnishes a quick means of identification. Errors are comparatively few, perhaps the most unfortunate being the statement that the lateral light stripe of the common garter snake is on "the third and fourth rows of scales" instead of on the second and third.

In an apparent attempt to facilitate leafing through the book while searching for the discussion of a specific species, running heads have been placed at the outer margins of the pages. This has resulted in a displacement of the page numbers to a position near the center fold, thus making it difficult to find a desired page after determining its number by consulting the index or table of contents. This defect could have been avoided by placing the folio numbers at the *bottom* outer margins of each page.

Both professional and amateur herpetologists will regret the lack of adequate documentation. There is no bibliography, although the discussion of each species is followed by one or more detailed references. However, there is much mention of scientific workers and statements about their conclusions without any explanation of who they are or where the results of their investigations are chronicled. The resulting inability to read further on many subjects is perhaps the volume's only major weakness.

"Amphibians and Reptiles of the Chicago Area," as a whole, is an excellent handbook and a worthy companion for its creator's long list of other outstanding contributions in herpetology.—ROGER CONANT, *Philadelphia Zoological Garden, Philadelphia 4, Pennsylvania.*

LOUIS AGASSIZ AS A TEACHER ILLUSTRATIVE EXTRACTS ON HIS METHOD OF INSTRUCTION WITH AN INTRODUCTORY NOTE BY LANE COOPER. Comstock Publishing Co., Inc., New York, 1945: vii–xi + 90, frontisp. $1.50.—The Society of Ichthyologists and Herpetologists is so much composed of teachers on one hand and of naturalists on the other, that I wish to call to the attention of the members a little book on Louis Agassiz' methods of teaching. Professor Lane Cooper, of Cornell University, has assembled the reports on their contact with the great naturalist teacher of four distinguished pupils—N. S. Shaler, A. E. Verrill, B. G. Wilder, and S. H. Scudder. These invaluable first-hand reports are supplied with an introductory sketch of Agassiz' life, a list of his pupils, and a sketch of his personality by Professor Lane.

Agassiz' continuing influence in the teaching of science, with his transmitted stimulation of enthusiasm for research as its fundamental background, gives the present little book an importance out of all proportion to its size. His extraordinary personality, with his ability to influence men of affairs in business and politics, sets an example now of paramount importance to the building of the bridge from the past to the Atomic Age.—KARL P. SCHMIDT, *Chicago Natural History Museum, Chicago 5, Illinois.*

THE REPTILES OF MARYLAND AND THE DISTRICT OF COLUMBIA. By Robert H. McCauley, Jr. Published by the author at Hagerstown, Maryland, 1945: iv + 194, figs. 1–46, photos 1–48. $2.50.—Residents of Maryland, as well as herpetologists and naturalists in general, will benefit by the publication of this detailed summary of the six kinds of lizards, twenty-six snakes, and twelve turtles that are known to occur within the borders of the Old Line State. Not only is it the first thorough, modern study of the reptiles of an eastern state, but the peculiar shape of Maryland and its westward-extending panhandle result in the presentation of a cross-section survey of the species inhabiting the Coastal Plain and all the other physiographic provinces west to the Appalachian Plateau. The report is based upon three seasons of intensive field work supplemented by data gleaned from museum specimens and the notes and records of Dr. McCauley's Maryland friends and colleagues.

The treatment of each species is in great detail. The descriptions are more than adequate, and the extent of variations in scutellation and pattern is summarized so completely that future monographers of species or genera should find the volume of considerable value. Also noteworthy are the many original observations upon feeding, breeding, and other habits; only information obtained from specimens observed or collected in Maryland and the District of Columbia are included in the text. There is an identification key and an index. A number of pages are devoted to the physical features of Maryland, and these cover the subject well except that much more could have been included under the topics of surface rocks and soils and the dominant vegetation types of the several faunal regions of the state. Of special interest is an annotated account of the species that have been incorrectly recorded from Maryland by previous authors, which obviously should be expunged from the list. This is particularly useful in view of the multiplicity of errors that appeared in an earlier work on the "Snakes of Maryland" by Kelly, Davis, and Robertson (published in 1936).

The Maryland distribution of each species and subspecies is indicated upon a series of outline maps. There are illustrations of all the forms, but, unfortunately, they leave much to be desired. Not only were most of the original photographs made from specimens collected in other states, but they have suffered in reproduction from improper cropping and especially from the marked inadequacy of offset printing. Consideration should be given to the fact, however, that Dr. McCauley personally bore the expense of publishing his own volume, and the saving encountered by employing this method of reproducing the photographs must have been a considerable item. Only 500 copies of the volume were printed; they may be purchased from the author by writing to him at 906 Potomac Ave., Hagerstown, Md.

The only other criticism that might be leveled at the "Reptiles of Maryland" is that it has a tendency toward verbosity. This is a minor fault, however, in view of the wealth of its data, its careful documentation, and the obvious thoroughness with which the author has pursued his topic.—ROGER CONANT, *Philadelphia Zoological Garden, Philadelphia 4, Pennsylvania.*

EDITORIAL NOTES AND NEWS

Research Fund

A HIGHLY important step taken by the Society at the April meeting was the establishment of a REVOLVING RESEARCH FUND, designed especially to assist the younger members in amplifying their initial researches, to furnish small grants for the furtherance of specific research projects in any appropriate phase of ichthyology or herpetology. Aid is to be given such projects as field studies and collecting; special researches at museums and universities; needed research equipment; preparation of manuscripts and publication of papers. Grants are to be made only to the individuals carrying on the research and it is hoped that recipients will replenish the Fund, when they are able to do so, by an amount at least as large as they have received. By this means, and by contributions from the members of the Society, this worthwhile project may be maintained indefinitely.

Each person or institution making a contribution prior to October 31, 1946, will be enrolled on the records of the Society as a Founder of the Revolving Research Fund. Checks should be sent to the Fund Committee Secretary, MR. F. H. STOVE, Box 109, La Jolla, California, and should be made out to the Ameircan Society of Ichthyologists and Herpetologists.

As we go to Press, a telegram from our President, DR. CARL L. HUBBS, informs us that contributions to the Fund have been most generous, making immediately available more than $1000. Applications for grants are now receivable: they may be sent to DR. C. L. HUBBS, Chairman of the Revolving Research Fund Committee, Box 109, La Jolla, California.

News Notes

DR. WILBERT M. CHAPMAN and DR. ROLF BOLIN have been granted Guggenheim Fellowships. Dr. Bolin will travel around the world studying the taxonomy of the Myctophidae, examining type specimens in North America, Europe, Asia and Australia. He will begin the project September 1, 1947.

Dr. Chapman will study the taxonomy, morphology and distribution of the tropical Indo-Pacific fishes, particularly the Blenniidae.

PETER SCHMIDT, under date of January 7 (in a letter to Leonard Schultz), writes, ". . . during the last five years I have been unable to publish anything, and could do nothing but work on my old manuscripts. After spending a very hard year here (in Leningrad) in blockade, I was evacuated to western Siberia, where I lived well and quietly in a health resort, but far from books and collections. In the spring of 1944 I was called to Moscow, where our Commissariat of Fisheries charged me with compiling a review and a revision of all the results of the fish and fishery investigations in our Pacific waters for the last 20 years. This work, making up two large volumes, is now completed and probably will be published this year. It contains much new and unpublished material, especially on the Pacific Salmonidae. It is a pity that this work will be unavailable to American ichthyologists studying the same species in the eastern Pacific.

"I also completed my large monograph "The Fishes of the Okhotsk Sea," containing descriptions of about 20 new species and subspecies of fishes and a revision of all the other 276 known species. In the theoretical part, I come to some new conclusions about the connections between the Okhotsk fauna of fishes and the Arctic fauna. I find that all the real arctic species (as also many boreal ones of the Atlantic) have their roots in the Pacific and especially in the Okhotsk Sea, as the coldest place in the ocean. I presume that the Arctic ichthyofauna has its origin in the Pacific temperate fauna migrating to the Arctic waters of Asia and America during the warmer period of the Pliocene. I believe this is proved by the very close relations between both faunae.

"Our science suffered greatly from the war. Many ichthyologists were lost, and progress was slackened. But we hope that closer connections with your country and with

England will create such a unification of our scientific forces as to compensate for all these losses."

Professor Schmidt's address is Mytninskaya Nab. 9/2, Leningrad 49, U.S.S.R.

THE SMITHSONIAN INTERNATIONAL EXCHANGE SERVICE announces the following rules for those wishing to contribute to restocking foreign libraries:

1. Consignments from correspondents in the United States containing packages for transmission abroad should be addressed—

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Carriage charges to Washington should be prepaid by the senders. Government franks cannot be supplied for this purpose.

2. In forwarding a consignment, there should be mailed to the Institution a letter of announcement giving the number of boxes or packages comprising the shipment.

3. Packages, except those containing single books, should not exceed 4 pounds 6 ounces in weight. This limitation, however, need not apply where a large number of publications is for one address. Packages for Latin-American countries may weigh as much as 22 pounds. The paper or envelopes used in wrapping publications should be of good quality. Packages should not be sealed but tied with string.

4. Letters are not permitted in exchange packages.

5. If donors desire acknowledgments, packages may contain receipt forms to be signed and returned by the consignee. If publications are wanted in exchange, a request to that effect may be printed on the receipt-form or on the package.

6. The work carried on by the International Exchange Service is restricted to the transmission of publications sent as gifts or exchanges.

A query addressed to the Post Office Department relative to the mail service for third class or printed matter to foreign countries, has brought forth this information: The classification of "third class matter" does not exist in the international postal service. Printed material may be mailed either under the classification of "printed matter" at the postage rate of 1½ cents per two ounces and subject to the weight limit of four pounds six ounces per package, or as parcel post, in which case the postage rates and weight limits vary for different countries of destination.

The mailing of printed material has not yet been authorized either as printed matter or as parcel post to Bulgaria, Estonia, Latvia, Lithuania, or Rumania, though limited mail service for letters and post cards is in effect in these countries.

To Italy, the material in question is admitted only as printed matter and may not be sent to the Provinces of Gorizia, Trieste, Fiume, Pola or Zara.

To Belgium, Czechoslovakia, Denmark, Finland, France, Greece, Luxembourg, Netherlands, Norway, Poland, Switzerland and Yugolsavia, the weight limit for printed matter packages is one pound, while parcel-post packages are accepted up to eleven pounds.

To the Dodecanese Islands, printed matter packages are accepted up to one pound in weight, and no parcel-post service is in effect.

ANTIQUARIUM BATAVUM, of the Hague, Netherlands, ANTIQUARIAAT JUNK (DR. R. SCHIERENBERG), of Lochem, Netherlands, LUDWIG ROSENTHAL'S ANTAQUARIAAT, of Hilversum, Netherlands, and GÉ NABRINK'S BOEKHANDEL EN ANTIQUARIAAT, of Lochem, Netherlands, announce in a joint communication that they have saved their entire stocks of antiquarian books through the war. The members of their staffs, after several years of underground existence, have rejoined these firms. Those wishing to receive catalogues, including those who were on pre-war mailing lists, should send their names and addresses to Antiquarian Booksellers, Lochem (G) Netherlands, Postbox 5. This is evidently a temporary address pending reconstruction at The Hague.

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